THE
OF MICHIGAN
T 19 1951
ENGINEERING

an international monthly

Petroleum Engineer

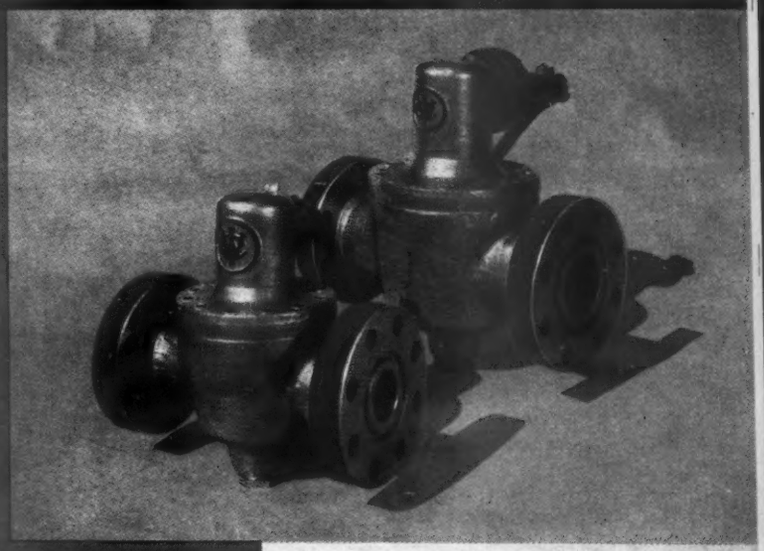
Combined Edition

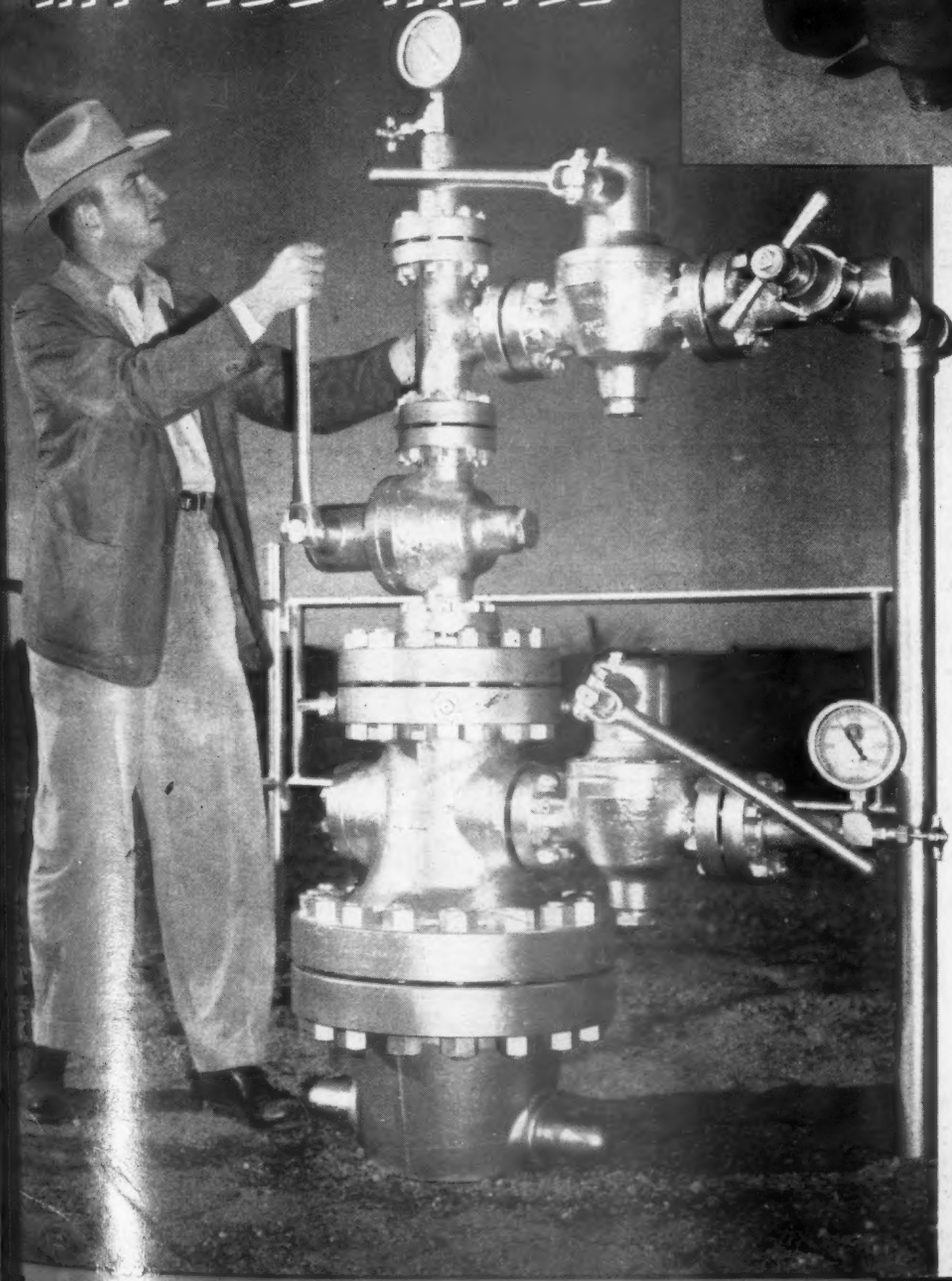
Drilling and Producing | Refining and Gas Processing | Oil and Gas Pipelining

Cameron

NON-LUBRICATED

LIFT-PLUG VALVES





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le of Contents Page 3 • Advertisers' Index Page 6
W MACHINERY AND SUPPLIES E-53

OCTOBER 1951

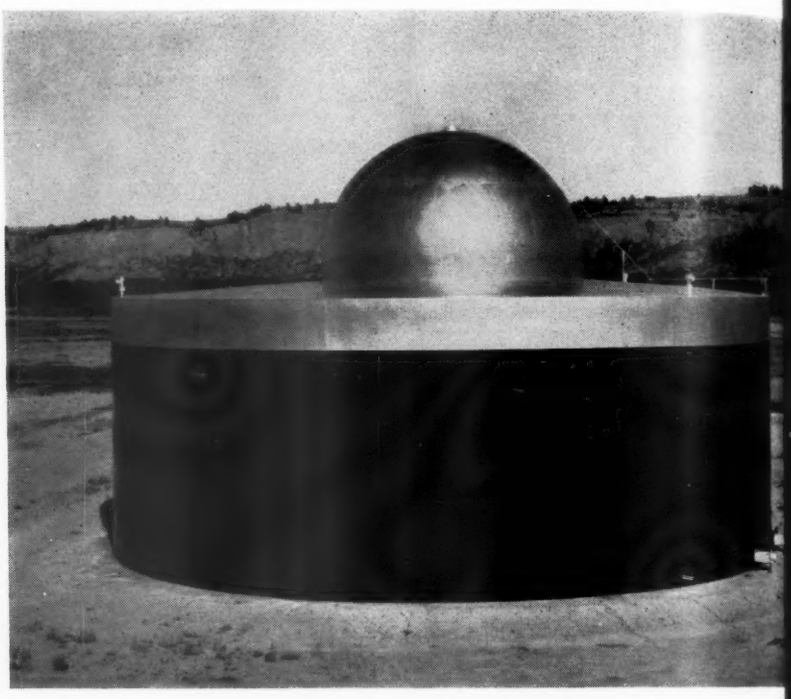
THE HORTONDOME ROOF

Effectively Reduces Evaporation Losses from Standing Storage

The Hortondome Roof is an economical, effective means of reducing evaporation losses from crude oil or gasoline standing storage tanks. Reason for the effective performance of the Hortondome Roof is found just underneath the dome. It is a flexible, impervious membrane that provides temporary storage for expanding vapor. When atmospheric temperatures rise and the air-vapor mixture in a tank expands—this membrane is pushed upwards into the dome. When the temperature drops and the air-vapor mixture contracts—the membrane returns to its original position.

The Hortondome Roof can be used to serve a single tank—or to form the central unit of a vapor saving system with several interconnected cone-roofed tanks.

For more information on the Hortondome Roof or any other Horton structure—write our nearest office.



Above: A Hortondome Roof tank storing base gasoline stock at the Continental Oil Company refinery at Billings, Montana.

Below: The diagram illustrates how the vapor spaces of several cone-roof tanks can be connected to a tank with a Hortondome Roof.

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OCTOBER, 1951 • VOLUME XXIII • NUMBER 11

GENERAL

The Engineer's Place in Management A-51
S. F. Bowlby
Freedom Is Industry's Need A-54
Oil Film Thickness Indicators for Sleeve-Type Bearings A-55
Shovel Crane Service A-58
A. E. York
New Flow Meter A-63
Small Gas Turbine Has Wide Power Potential A-68

Features

Course of Oil A-4
With the Editors A-8
Highlights in Oildom A-10
Petrolic Personalities A-12
Dick Sneddon
Meetings A-18
Petroleum Profile A-70
Douglas Hayes Graham
News E-2
Personals E-12
The Petroleum Engineer's Continuous Tables E-15
(Installment No. 171)
Laugh With Barney E-36
Oil and Gas Trade News E-38
Trade Personals E-46
New Machinery and Supplies E-55
Trade Literature E-60
Books E-62

DRILLING AND PRODUCING

Lost-Circulation—A New Fibrous Material for Its Correction B-7
E. E. Glenn, Jr., and R. Jenkins
Effective and Total Porosity in the Redwater D_3 Reservoir, Alberta, Canada B-14
Walter Rose, Hugh Hay-Roe, R. G. Knabe, F. M. Tunnell
Heavy Portable Drilling Rig for Foreign Operations B-40
R. E. Norton and William Ohlandt, Jr.
Principles of Gas Anchor Design B-48
Norman C. Wells
Hydrafrac Methods for Limestone and Dolomite Wells B-53
C. E. Clason
Pipe Racks and Safe Handling of Pipe B-58
Oil Operations of the Long Beach Harbor Board B-63
Richard Sneddon
Water Injection B-72
Thomas P. Harris
A Seismic Research Laboratory on Wheels B-78
W. E. Pugh
Improved Drilling Fluid Filter Loss Tester B-84
J. F. Chittum, M. B. Standing, W. T. Cardwell, Jr.
Production History of Main Western Pool, North Coles Levee Field B-92
W. J. Travers, Jr., and F. T. Lloyd
The Role of Workovers in Coastal Texas and Louisiana B-104
Sidney A. Judson
Trucks and Cars in Oil Industry Increase B-107

Features

Presenting B-3
News B-108
What's Doing in Drilling B-116
Exploration Activities B-120
Running Tour With Men in the Industry B-126

REFINING AND GAS PROCESSING

Chemists Survey Oil Refining Technology C-3
Arch L. Foster
New Design Features in Cat Cracker C-5
H. K. Wheeler
Flexibility Achieved by Modernization C-11
Arch L. Foster
Design of Gasoline Plants—Part 1 ..... C-16
O. L. Lewis
First Orthoflow Unit Put on Stream in Canada C-22
Montreal Modernization Doubles Refining Capacity C-24
Harry Chapin Plummer
Instrumentation in the Petroleum Refining Industry C-34
The Wohl Equation of State Applied to Light Hydrocarbons C-35
K. A. Kobe and H. E. von Rosenberg
Cost Estimating for Refineries C-39
Robert P. Wilson
Insulation and Application Methods for Heated Piping C-44
Factors Affecting Throughput C-47
P. M. Reynolds

Features

News C-52
Refining and Gas Processing Personals C-62

OIL AND GAS PIPELINING

Use of Trucks in the Pipe Line Industry D-3
Frank H. Love
Centrifugal Compressors for Pipe Lines D-9
C. F. Koenig, III
Microwave Communications for Pipe Line Use D-20
E. B. Dunn
Installing Hudson River Crossing D-34
Frank H. Love
Safe Operation of Compressor Stations D-37
E. A. Koenig
Diesel Type Engines Operate on Crude Oil D-41
Richard Sneddon
Vast Expansion Program Underway D-48
Important Subjects on AGA Convention Program D-51

Features

News D-52
Pipeline Personals D-60
Pipe Line Projects D-62
With the Pipe Line Contractors D-66

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the Course of OIL

THE GREAT HAZARD

In urging that we as an industry must stop the trend toward persistent encroachment of government controls and regulations, A. C. Rubel, vice president of the Union Oil Company of California, addressed the American Association of Oilwell Drilling Contractors at Fort Worth, Texas, and pointed to the "powerful forces in high places diligently at work in our country today bent on changing or destroying our time-proven American system of getting things done. They seek to substitute bureaucratic controls for the free play of economic forces, and master planning for individual initiative and resourcefulness."

A ringing indictment of this trend is the fact that:

"We have many acts of the government that cause us much concern in our industry. We are taxed at all points by every municipal, county, state, and federal authority until the profit incentive in many segments of the industry is seriously threatened, and many small producers have found it more advantageous to sell out their holdings and take advantage of the capital gains tax rather than to stay in business.

"Constant attempts are made by the Treasury Department to decrease or eliminate statutory depletion on the indefensible grounds that in some way it is a subsidy or a special provision for tax evasion reserved for the special use and privilege of the oil industry.

"The Federal Power Commission, through the guise of regulating gas at its source, has made numerous attempts to move in on both our oil and gas fields.

"The Administration, with the aid of the Supreme Court, has so tied up the tidelands as to make them inaccessible for development under either state or federal jurisdiction. They probably constitute one of our greatest future potential reserves and can do much to extend the life of our reserves. Congress and the Administration kick this about like a football.

"The Department of Justice, under the various anti-monopoly provisions of the statutes, plagues and harasses us constantly under the guise of protecting the public interest against monopolistic practices.

"In California, for example, the seven so-called major companies, and the Conservation Committee which represents all producers, are defendants under a Department of Justice suit that seeks to break up the integrated companies, separating production, transportation, and marketing, and to prevent any voluntary attempt on the part of the industry at conservation practices in its producing operations. I am certainly not qualified to pass on the legal points involved, but I do know the facts; and it is clearly apparent that the primary purpose of the action is based more on political expediency than on legality.

"The preparation of our defense is consuming many thousands of man hours—technical, legal, and clerical—which are sorely needed for productive efforts. At the same time, we are being urged to an all-out effort to supply more products to the military."

Bureaucratic controls have been aptly expressed as the "greatest hazard" confronting the industry's future.—K. C. S.

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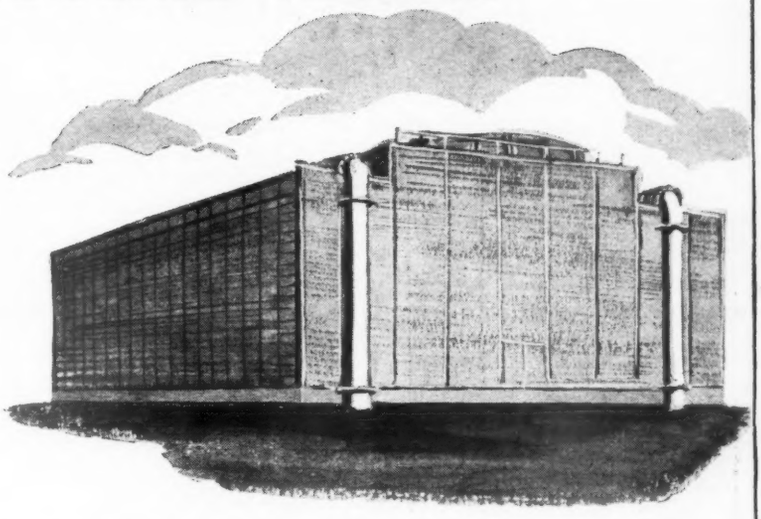
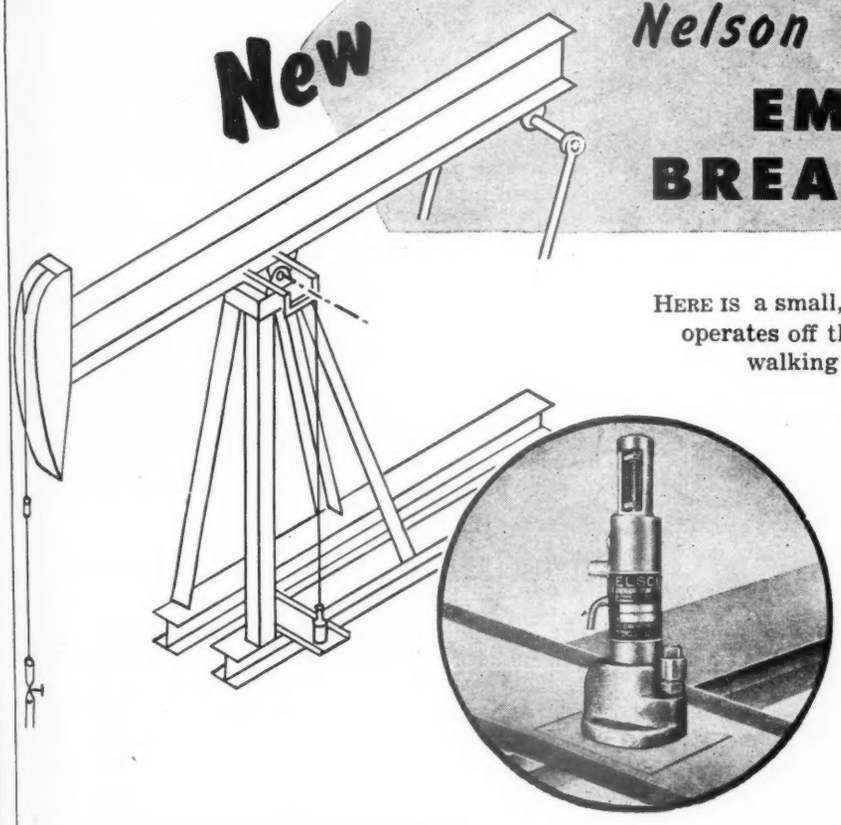


New

Nelson Walking Beam EMULSION BREAKER PUMP



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With The EDITORS . . . . . .

More Lead or Fewer "Octanes"

"Get the lead out" to tetraethyllead makers or take a drastic cut in TEL allotments, says C. E. Davis, Shell refining vice president and currently refining director for PAD. Addressing the National Petroleum Association, oldest of the petroleum organizations, Davis stated aviation gasoline will continue to be 'tight,' while jet fuel and its production may in future prove to be more of a problem to refiners than it has been to date. Only 40 per cent of the quantity of metallic lead required by the TEL manufacturers was allocated to them by the NPA September order. If this rating rises as high as 47 per cent then the reduction in octane ratings will average three numbers "across the board," Davis indicated. Correction of this situation can be made by inducing NPA to make up the required allocation from our large stockpile of metallic lead, basing this proposed action on the vital importance of TEL in maintaining gasoline quality and thus the nation's civilian economy.

More primary lead sources must be developed in order to enable authorities to allocate more lead to TEL manufacturers. Also the flow of scrap lead to these purposes must be re-established to avoid the cut to refiners. An additional complication is the necessity for coordinating the industry to make up for shortages in the European and Near East petroleum supplies caused by the shutdown of Abadan's huge refinery.—A.L.F.

Revealing Statistics

Evidence of the growth of crude oil transportation by pipe lines during the last decade is shown in statistics released by the Interstate Commerce Commission. Figures are given for the first half of the years 1941-51 showing the volumes of oil handled and transportation revenues. For the first half of 1951, both volume and revenue exceeded that of any corresponding period during the 10 years.

During the first six months of 1951, 1,507,194,000 bbl of crude oil were moved through pipe lines, representing revenues of $234,828,136. In the same period of 1950, 1,220,430,000 bbl were transported and revenues totaled $186,748,007. To give a comparison with 1941, during the first half of that year 688,759,000 bbl were moved, and revenues were $112,514,173. These figures are based on quarterly reports of oil pipe lines having revenues of more than $500,000 per annum.

Percentagewise this means that the traffic volume for the first half of 1951 increased 23.5 per cent over that of 1950 and revenues were up 25.7 per cent. In comparison with the 1941 period, the increases were 118.8 per cent and 108.7 per cent, respectively.—F.H.L.

Is This Foresight?

The Trunkline Gas Company has laid the last joint of pipe in its system extending from Louisiana and Texas into Illinois, some 1300 miles. Texas Illinois Natural Gas Pipeline Company's 1404-mile line from Texas into Illinois will be in operation about December 1. Completion of these two long cross-country carriers gives rise to some speculation regarding when the next pipe line project of equal magnitude may go into actual construction, in view of the current difficulty in obtaining sufficient steel for pipe.

Although Interior Secretary Chapman, Senator Joseph O'Mahoney, and a few others, realize the importance of oil and gas and the necessity of getting it to the localities where it can be used, apparently there are some in government high places who are not so entirely cognizant of this need. It has been a difficult task to procure steel in sufficient quantities to meet bare essentials. In fact, the bare essentials have gone begging in some cases, as witness the Platte Pipe Line. In this instance, 100,000 bbl of available crude oil a day has had to be left in the Rocky Mountain region for lack of transportation. On PAD's fourth quarter allotment, 52,000 tons of steel were granted this project, but an additional 100,000 tons are needed to finish the 1020-mile line.

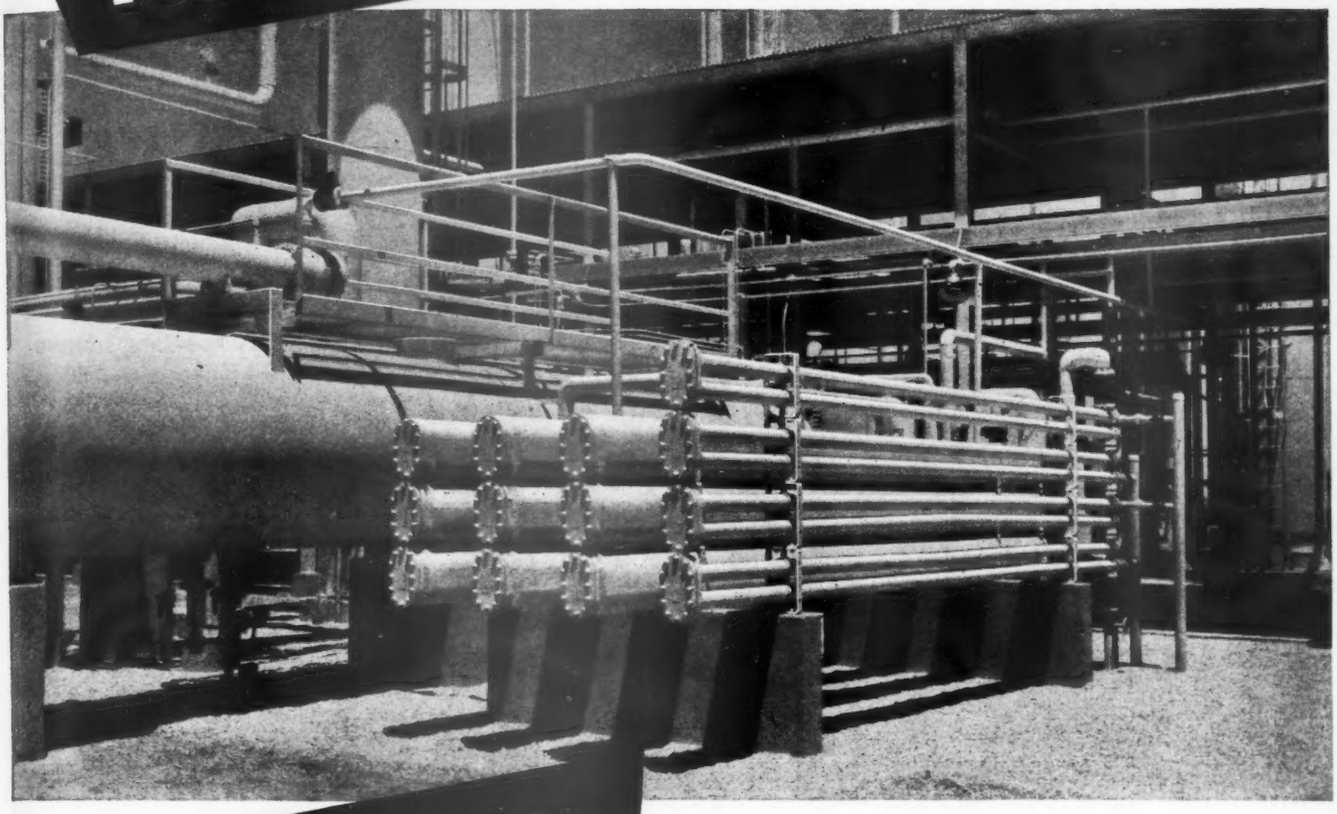
According to a recent ruling, gas pipe lines cannot be laid into areas not already served by natural gas. This prevents the opening up of new areas that could use natural gas more advantageously than their present fuels.

Apparently there is a shortsightedness somewhere in the matter of steel allotments. The pipe line industry does not wish to be selfish in this respect, but everyone knows from experience of the last war what hardships and dangers can result from a lack of oil and gas in the right places at the right time. This means, essentially, pipe lines to get them there. Foresight now may prevent difficulties later.—F.H.L.

Products, Profits in Petrochemicals

The "revolution" in the chemical industry via petroleum-derived chemicals yields a young and lusty industry, Dr. Wayne Kuhn, The Texas Company's research director, told National Petroleum Association. The petrochemical industry is not "a touchstone for profit." Caution signs must be heeded by the investor, Kuhn warned. Present expansion rate will not slow up for years to come. Now one-fourth of our total chemical production is from petroleum; in ten years it will rise to more than 50 per cent, be worth more than $5 billion, and quadruple the amounts of synthetic chemicals now made. Requirements for ethylene alone may treble during this period; polyethylene plastics and other derivatives may increase by 1000 per cent.—A.L.F.

Assure Flexibility in your plant



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HIGHLIGHTS IN OILDOM

INDUCEMENT TO EXPAND

The U. S. Government has a big new inducement to coax oil companies to expand their aviation gasoline output. Federal lawyers said the new plan is a last-ditch effort to keep the Government from having to build its own plants, which it can do under the Defense Production Act.

The lure is known as a "facilities contract." It amounts to a Government promise that a company won't lose any money on its expansion investment. It's by far the biggest inducement yet prepared by the mobilization planners to get defense-needed expansion.

RECORD DRILLING

A. W. Thompson, president of American Association of Oil Well Drilling Contractors, told a record number of nearly 1000 delegates to 11th annual meeting that footage drilled is expected to reach an all time high of 172,000,000 ft in 1951, an increase of 7.7 per cent over the 159,000,000 ft in 1950, two-thirds greater than 1946 and almost twice the level of 1940. He said wildcat activity has increased sharply, with more than 9100 wildcats predicted in 1951, up 2½ times over the prewar peak of 3409, and more than double the 4242 drilled in 1946.

FEDERAL CONTROL OF GAS

Many producers of natural gas have been reluctant to dedicate their reserves to the interstate market for fear of federal regulations, Rayburn L. Foster, vice-president and general counsel of Phillips Petroleum, told the mineral section of American Bar association at New York.

"More than 87 per cent of the proved reserves not yet committed to a market are owned by independent producers. . . . Regulated natural gas companies have not engaged in the risk-taking discovery phase of the business," Foster asserted, but cited that 30 oil companies spent $318 millions in such search for new reserves in 1948 and 1949.

NICKEL-BEARING RODS CUT

Only about 35 per cent of the future sucker rods will have nickel content in them, according to Bruce K. Brown, deputy petroleum administrator. Reason for the cutback is the shortage in nickel-bearing steel. Rods, used in pumping wells, with nickel content aid in resisting erosion if the oil has a high sulfur content.

AIOC REVENUES

In view of the fact that suspension of oil revenues has apparently crippled Iran's finances, it is surprising to learn from the "London Economist" that the payments by the Anglo Iranian Oil Company to the government of Iran constituted only 15 per cent of Iran's revenues. The payments were made under the 1933 agreement, and the Supplementary Agreement that was to go into effect in 1950 but did not because of a technicality, would represent about 43 per cent of the total Iranian budget. It is possible, but not mentioned that the 1950 budget for Iran was based on the proposed rise in revenues.

One of the peculiar developments at this time is the effort of Iran to sell oil to the Soviet satellites, Poland and Czechoslovakia, while the effort of Britain is directed toward buying from Red satellite Romania.

EUROPE REFINING CAPACITY HIGH

The major part of the oil products required by European countries will be supplied by its own refineries by 1952-53, the Economic Cooperation Administration has reported. According to a report by the Oil Committee of the Organization for European Economic Cooperation (EEC) refinery capacity of Marshall Plan countries will soon be self-sufficient.

COLLECTION OF OIL DOCUMENTS

Ernest Miller, West Penn Oil Company, has collected more than 2000 books, maps, letters, pictures, and other historical material relative to the oil industry. A private collection that has been acquired piece-by-piece, it is valued at several thousand dollars. Many items in the collector's possession are rare museum pieces. A certificate dated December 22, 1855, reportedly is the only one to have survived the 96 years; Thomas A. Gale's "The Wonder of the Nineteenth Century! Rock Oil in Pennsylvania and Elsewhere," which is one of three known copies in existence, are but two of the many items. Gale's book was written in 1860, the year after Drake struck oil, and is the first book devoted exclusively to petroleum in this country.

A PICTURE OF TAXES

Income tax paid by the Socony-Vacuum Oil Company, Inc., for 1950 amounted to $1000 for each employee in the United States. Uncle Sam also collected about $56,000,000 more out of the $200,000,000 paid in salaries and wages to Socony employees in the United States. Stockholders paid an estimated $14,000,000 in taxes on their dividends from the company. In addition, the company collected $180,000,000 in excise and sales taxes on gasoline and other petroleum products.

Thus the government collected over $330,000,000 all told directly from Socony-Vacuum and its stockholders and employees. This was $156,000,000 more than the employees and stockholders had left in their hands.

NATION NOTES OIL PROGRESS WEEK

Oil Progress Week, which is four years old this year, is said to be the biggest in its history. Luncheons, dinners, parades, and speeches are being held all over the country in honor of the ever-expanding oil industry. In Utah, oil men are hosts to community leaders and one high school senior from each of the 40 school districts in that state. T. S. Peterson, president of the Standard California, will be the principal speaker. Each high school student will tour a refinery, visit an oil field, and on his return home will give an oral report to the school assembly.

RICHFIELD TELECASTS PEACE SIGNING

Richfield Oil Corporation held exclusive sponsorship of the telecasts of the Japanese Peace Treaty Conference in San Francisco, California, recently. W. G. King, Jr., vice president of the company reported that purchase price was $75,000. Telecasts viewed the actual opening of the Conference, the seating of delegates, and various highlights of the conference.

WORLD METAL GROUP DISCUSSED

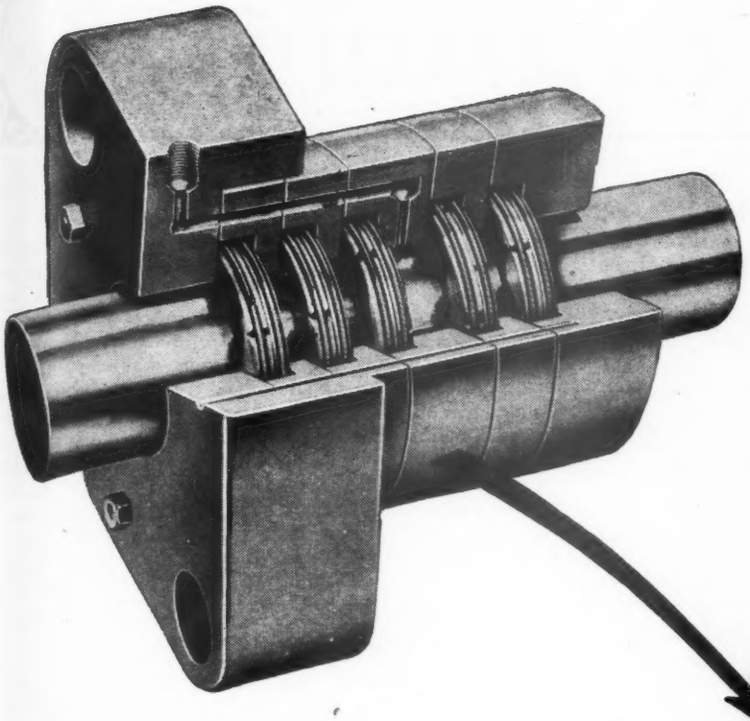
A world committee on metal substitutes to "better coordinate American and Marshall plan efforts to conserve scarce metals strategic to defense" is being discussed at the World Metallurgical Congress in Detroit, Michigan. Walter E. Jominy, president of the American Society for Metals and chairman of the U. S. Government's panel on conservation of alloys in engineering steels, has requested an international counterpart to the American panel be drawn from recommendations received at the meeting.

PEANUT LINE SOLD

The Israeli government has bought the British Government's 130-mile pipe line from the new port of Mtwara to Nachingwea, which was built for the British's peanut (or as they say, groundnut) scheme. The British planned to grow peanuts for food in Tanganyika. Israel is reported to have paid about £250,000, payable in U. S. dollars, for the line which cost the British £400,000.

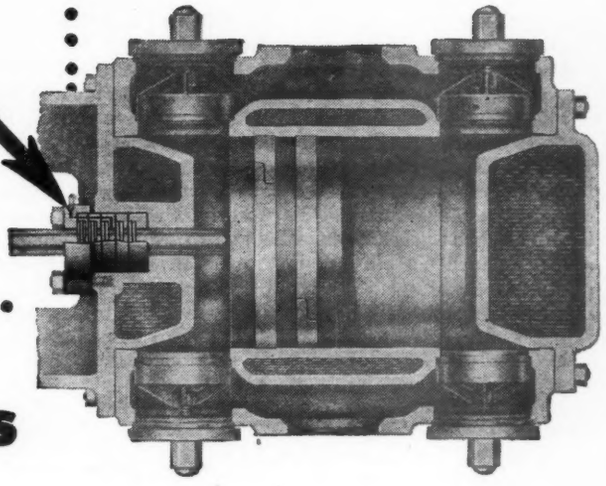
ITALY CHANGES MINING LAW

Amendments to the 1927 mining law in Italy are due to come before the Italian parliament in the near future. The Po Valley, Italy's hope for oil production, has been placed under a government organization, the Ente Nazionale Idrocarburi, even though a new law has been passed. Government officials hope that this new organization will be able to negotiate with private companies much the same way as Petroleos Mexicanos has in Mexico.



MODERN PACKINGS

boost the efficiency of MODERN COMPRESSORS



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Metallic Rod Packings

Now, as never before, design engineers are taking advantage of modern friction-reducing devices in order to improve compressor efficiency and dependability.

This is why Cook full-floating all-metallic packings are used as the modern rod seal in so many newly developed compressors. Backed by over 60 years of specialized experience in the manufacture of piston rod seals, Cook packings are designed to function with a minimum of friction. They do this primarily by utilizing rings of proven anti-friction materials. These rings float in specially provided grooves which means that, even when rod vibration or misalignment develops, friction is not materially increased nor is the seal disturbed.

Be sure that your compressor comes equipped with this modern packing. Specify Cook by name when you order new equipment just to make sure.

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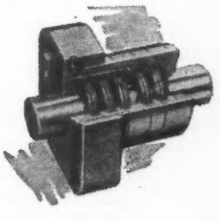
COOK GRAPHITIC IRON
ROD PACKINGS



. . . SEALING PRESSURES SINCE 1888 . . .

PETROLIC PERSONALITIES

SCRATCH HANDICAPPER DIVISION LAND MAN

Square dancers and other ranch hands in the vicinity of Glendale, California, are moaning like so many banshees over the distressing news that Spence Hamilton, the Humble Oil and Refining Company's land chief out on the Pacific Coast, has folded his tent and skipped to Corpus Christi, Texas. There he is engaged with Charlie Mahaffey, another ex-Humbletonian, in a joint mineral royalty and lease brokerage concern, which we certainly hope will prosper. Spence is a mighty likable sort of chap and we happen to know that many a "lily white hand" thrilled to the touch of his strong manly digits as he swung trippingly through the measures of an *allemande left* or a *do-si-do* out there in the Glendale municipal auditorium. Charlie Mahaffey, incidentally, is an old Baylor grad who cut quite a swath on the Waco campus in his day and is still a dangerous character with a good drawing hand.

Spence has been succeeded at the Humble plant by Maury Hankinson, perhaps the only Texan ever to be born in Seattle, Washington. Maury moved to the Lone Star state while he was still knee high to a Brunton compass, became thoroughly conversant with the language, in due course graduated from Oklahoma University at Norman, and meantime has developed into one of the oil industry's sharpest niblick manipulators. His handicap is a large zero, and being sworn to work for the good of the western petrolic people, we hereby warn them one and all not to tangle with this Hankinson person on the links unless they are substantially heeled and don't mind taking a sizable rap in the wallet. Jack Naumann has been named assistant division land man for Humble in California and with Maury should make a pretty productive team.

HUGHES VERSUS HUGHES

Out of New York comes a report that one of its favorite citizens, Jim Hughes, export manager of Cooper-Bessemer, has recently returned from a trip to Venezuela. This was his second journey into the same area within 30 days, and what all the galivanting about has done to his golf swing and stance has him worried no end. He has been heard to remark that even the gophers are getting bowlegged trying to stay under his wood shots.

By a peculiar coincidence another Jim Hughes, executive of Lane Wells, is also at the moment wondering why it is that when he is warming up he can smack an empty cigarette package or a dried oak leaf square on its periphery, but when he lays down a golf ball, the thing actually leers at him and gives him an inferiority complex that is nothing short of devastating. We have just been thinking it would be a good idea to stage a match between Jim Hughes of New York and Jim Hughes of Los Angeles to determine whether travel is more destructive to one's golf than the sinister leer of a bumptious pellet.

VENEZUELA VISITORS OPTIMISTIC

We also note that Val Wittich, the New York export representative, and Bob Gaylord, the Wagner Morehouse chief engineer, just returned in the beginning of September from a prolonged visit in Venezuela. They were both much impressed by the general progress of the country in the matter of improved and extended roads, new buildings, modernized schools, and all the ordinary indications of advance. Last time we saw Val was at the Nomads Whingding out at the Riviera Country Club where he came within an ace of being caught in the middle of a quartet that was just about to swarm. It was only by some right fast footwork that he was able to avoid being engulfed and when he later heard the caterwauling that resulted from this agglutination he must have been a very happy man. He is a top ranking engineer and has a lot of friends who think highly both of his technological understanding and his friendly disposition.

NOTED NIMROD ON PACIFIC COAST

Occasionally we engage in a fierce domino encounter with Tom Wallace, Paul Broxon, Jim Leovy, or Glen Ledingham, an assortment of interesting folk from Western Gulf Oil Company who have an uncanny knack of drawing out of the boneyard exactly the rock that is required to make a high five multiple and at the same time apologizing so profusely for doing it that the gesture doesn't hurt a bit—that is, if the drawer happens to be your partner. Occasionally also one of these sharpies wanders into the Los Angeles Petroleum Club with a distinguished visitor from other parts, which is how we met that well known Houstonian, John Cooper, assistant production superintendent for Gulf in the Houston division, and a man of rare qualities if we ever saw one. John is a graduate of Carnegie Tech who almost immediately upon acquiring his sheepskin attached himself to Gulf and has remained a firm adherent of that illustrious institution for 30 years.

DOESN'T LIKE BUNKERS

Another New Yorker with whom we traded reminiscenses not too long ago was Frank Shlemmer, division purchasing agent for the Texas Company in the Big City. Frank is a Brainard, Minn., boy who saw the error of his way and, taking his people with him, hied out to California when he was just 7 months old. He began his oil career with the old Calpet at Signal Hill in 1927 as a roustabout and roughneck. By 1942 he had become a buyer in the purchasing department at Los Angeles and one year later he was appointed assistant purchasing agent. In 1947 he was transferred to New York but he still ducks back to California at every opportunity. He is a member of that distinctly exclusive California organization, the Nineteeners and is never happier than when he has just climbed out of a sand-trap and hasn't quite had time to climb into another.

DATA ON IMPORTANT OIL FIELDS OF THE UNITED STATES

No.	Annual production (thousands of barrels)						Cumulative production thru 1947 (M bbl)	Estimated recovery per acre (bbl)	Number wells producing		
	1942	1943	1944	1945	1946	1947			Total	Flowing	Pumping
	R .R. Com. Dist. 4 (Contd.)						**TEXAS (Contd.)**				
100	746	1,167	1,396	1,296	1,180	1,062	17,599	4,240	161	46	115
101	398	670	857	646	575	522	5,313	2,281	54	33	21
102	742	844	794	863	725	526	8,726	3,565	85	18	67
103	398	557	808	723	875	1,657	6,935	1,466	234	133	101
104	902	1,046	1,071	1,036	932	1,040	9,887	2,471	63	38	25
105	221	193	197	195	158	160	2,595	4,427	43	0	43
106	444	495	516	201	185	177	8,846	2,349	202	0	202
107	423	698	1,031	1,027	892	692	11,690	4,819	65	34	31
108	91	272	455	386	364	360	2,178	1,515	20	20	0
109	0	78	224	1,217	1,360	1,426	4,305	1,440	97	87	10
110	2,130	1,518	2,550	2,294	1,852	1,962	60,696	6,781	583	1	582
111	1,386	1,502	1,546	1,308	1,110	1,081	15,453	4,227	292	3	289
112	252	543	881	1,053	1,388	1,692	7,559	2,551	99	83	16
113	31	14	10	215	732	1,561	2,595	230	103	100	3
114	1,667	1,610	1,391	1,089	1,013	1,085	32,947	4,300	406	1	405
115	985	946	881	777	705	613	16,381	4,550	266	0	266
116	774	1,223	1,545	1,309	1,016	914	13,659	5,094	138	116	22
117	875	1,086	1,191	1,238	1,126	1,582	8,666	3,542	96	49	47
118	759	745	675	619	600	809	5,255	2,964	73	18	55
119	96	93	83	85	71	64	9,696	13,746	36	0	36
120	367	649	771	720	694	793	4,036	1,247	77	71	6
121	775	658	563	552	500	484	13,432	5,885	134	0	134
122	548	791	—	770	556	613	6,912	4,845	110	0	110
123	2,765	3,427	3,519	3,181	3,182	3,440	42,492	10,414	78	46	32
124	631	960	1,202	1,194	1,063	1,132	7,488	3,178	81	81	0
125	1,777	2,327	2,710	2,464	2,332	2,498	15,945	2,766	161	131	30
126	43	78	214	525	579	632	2,159	3,818	46	33	13
127	2,499	1,309	1,359	1,884	2,254	2,205	65,092	4,492	169	40	129
128	298	1,530	7,441	10,743	12,733	15,035	48,201	2,653	653	640	13
129	2,073	1,845	2,393	2,345	2,244	2,234	28,764	6,002	375	1	374
130	666	1,715	4,078	4,002	3,583	4,334	19,173	1,099	248	247	1
131	262	804	1,197	1,095	1,102	1,189	6,548	2,233	81	73	8
132	25	237	563	523	506	684	2,538	1,854	42	39	3
133	360	463	1,102	1,040	856	950	9,765	12,243	75	32	43
134	0	0	248	979	3,348	3,492	8,067	3,813	140	140	0
135	550	469	482	472	466	498	6,864	531	41	35	6
136	1,125	946	924	784	638	547	6,759	3,106	65	28	37
137	2,860	3,852	4,507	4,491	3,737	4,585	32,396	5,794	248	205	43
138	26	123	1,268	2,827	4,691	4,826	13,802	1,403	212	202	10
	R. R. Com. Dist. 5										
139	139	127	128	124	121	122	17,420	2,578	559	0	559
140	37	36	28	27	25	25	7,081	14,855	13	1	12
141	562	514	501	484	494	473	100,838	25,603	154	0	154
142	0	0	8	346	617	499	1,470	571	38	37	1
143	554	508	475	451	437	401	118,149	39,249	125	0	125
144	1,538	1,509	1,419	1,341	1,246	1,182	16,273	14,372	68	0	68
145	3,404	6,215	11,636	10,966	10,583	10,454	183,105	36,579	584	272	312
146	167	132	102	84	73	74	23,403*	30,564	25	0	25
	R. R. Com. Dist. 6										
147	521 4,007	467 3,387	399 2,894	366 2,576	200 ® 2,437	— 2,550	— 39,663	—	202	47	155
148	53	487	814	856	824	801	3,853	—	28	12	16
149	120,681	128,569	134,768	131,022	120,574	118,642	2,465,536‡	—	22,742	13,031	9,711
150	8 5,445	3 14,224	1 13,317	— 12,392	— 13,934	17,090	77,856	—	598	553	45
151	1,376 1,304	1,128 1,379	1,173 1,750	1,001 1,736	651 1,722	654 1,774	9,264 14,146	—	133	82	51
152	0	119	1,007	1,639	1,277	1,475	5,517	—	75	29	46
153	3	647	2,073	2,157	2,338	2,955	10,172	3,138	98	62	36
154	3,065	2,174	1,722	1,400	1,133	964	58,816	5,293	216	32	184
155	9,505	9,220	8,673	8,203	8,720	8,888	101,314	11,774	724	4	720

*Wortham Shallow, discovered in 1912, included.
‡In addition, some 14,000 bbl. of condensate have been produced.

From The Petroleum Data Book, Second Edition, which carries 750 pages of information on the petroleum industry.

DATA ON IMPORTANT OIL FIELDS OF THE UNITED STATES

No.	Year discovered	Field	County	Producing formation	Gravity °API	Productive acres	Estimated average thickness (feet)
		R. R. Com. Dist. 4 (Contd.)		**TEXAS (Contd.)**			
100	1937	Benavides (incl. No. Sweden)	Duval	Cole; Eoc	43.0	3,900	19
101	1939	Ben Bolt	Jim Wells	Frio; Olig	36.0-43.0	2,100	14
102	1935, 37	Clara Driscoll (incl S.)	Nueces	Catahoula, Frio; Olig	23.0-40.0	2,300	12; 66
103	1936	Colorado	Jim Hogg	Cockfield; Eoc	47.0	3,600	10
104	1924	Conoco Driscoll	Duval	Frio; Olig	30.0	3,580	13
105	1933	Eagle Hill	Duval	Cole, Gov't Wells; Eoc	19.0-22.0	550	10
106	1914	Escobas	Zapata	Yegua; Eoc	20.0	3,690	12
107	1936	Flour Bluff	Nueces	Marg; Olig	43.0	2,280	25
108	1940	Flour Bluff, East	Nueces	Marg; Olig	42.0	1,200	8
109	1942	Garcia	Star	Frio; Olig	42.0	2,000	6
110	1928	Gov't Wells (Comb)	Duval	Cole, Het, Gov't Wells, Mirando, Yegua; Eoc	21.0	8,500	17
111	1933	Hoffman	Duval	Gov't Wells, Loma, Novia; Eoc	22.0-25.0	3,400	17
112	1938	Kelsey	Jim Hogg, Brooks, Star	Frio; Olig. Yegua; Eoc	44.0	2,300	13
113	1939	La Gloria	Jim Wells, Brooks	Frio, Vicksburg; Olig	39.0-55.0	4,500	19
114	1934	Loma Novia	Duval	Loma Novia, Mirando; Eoc	23.0	7,410	20
115	1935	Lopez	Duval	Mirando; Eoc	21.0	3,500	18
116	1937	Luby	Nueces	Catahoula, Marg, Frio; Olig	37.0-46.0	2,500	10
117	1937	Midway	San Patricio	Frio; Olig	38.0	2,000	15
118	1939	Minnie Bock	Nueces	Catahoula; Olig	23.0	1,500	10
119	1921	Mirando City	Webb	McElroy, Cockfield; Eoc	20.0	700	10
120	1939	Odem	San Patricio	Het, Frio; Olig	35.0	2,600	24
121	1937	O'Hern	Duval, Webb	Cockfield; Eco	28.0	2,200	15
122	1935	Piedre Lumbre	Duval	Cole, Gov't Wells, Loma Novia; Eco	22.0	1,300	10
123	1935	Plymouth	San Patricio	Frio; Olig	31.0	3,750	10
124	1937	Richard King	Nueces	Frio, Vicksburg; Olig	22.0-56.0	2,000	10
125	1938	Rincon	Starr	Frio, Vicksburg; Olig	48.0	4,500	20
126	1940	Rincon, North	Starr	Frio, Vicksburg; Olig	42.0	400	14
127	1923, 35	Saxet (Deep and Shallow)	Nueces	Catahoula, Het, Frio; Olig	24.0-40.0	14,000	10-18
128	1937	Seeligson	Jim Wells, Kleberg	Frio; Olig	36.0-50.0	12,500	20
129	1934	Seven Sisters	Duval	Cole, Frio; Olig	23.0	4,420	23
130	1931	Stratton	Jim Wells, Kleberg, Nueces	Frio; Olig	43.0	13,500	17
131	1938	Sun	Starr	Frio, Vicksburg; Olig	45.0	2,400	10
132	1941	Sun, North	Starr	Frio, Vicksburg; Olig	46.0	1,000	15
133	1935	Taft	San Patricio	Catahoula, Het; Olig	23.0	720	20
134	1944	Tijerina-Canales	Bee, J. Wells, Kleberg	Frio; Olig	36.0-40.0	1,200	15
135	1938	Turkey Creek	Nueces	Catahoula, Frio; Olig	20.0-38.0	12,000	8
136	1939	Wade City	Jim Wells	Frio, Vicksburg; Olig	32.0	2,000	10
137	1938	White Point (East)	San Patricio	Oakville; Mio. Catahoula, Het, Frio; Olig	39.0	4,800	17
138	1940	Willamar	Willacy	Marg; Olig	30.0	6,400	40
		R. R. Com. Dist. 5					
139	1895	Corsicana (Shallow)	Navarro	Nacatoch, Wolf City; Cre U	27.0	6,710	12
140	1921	Currie	Navarro	Woodbine; Cre U	40.0	475	20
141	1920	Mexia	Limestone	Woodbine; Cre U	35.0	3,920	50
142	1944	Pickton	Hopkins	L Glen Rose; Cre L	52.0	1,700	20
143	1923	Powell	Navarro	Woodbine; Cre U	38.0	3,000	18
144	1936	Sulphur Bluff	Hopkins	Paluxy; Cre L	23.0	1,050	40
145	1929, 33	Van (Shallow & Deep)	Van Zandt	Nacatoch, Woodbine; Cre U	33.0	4,720	20; 150
146	1924	Wortham	Freestone	Woodbine; Cre U	37.0	760	35
		R. R. Com. Dist. 6					
147	1934	†Cayuga	Anderson, Henderson, Freestone	Woodbine, Trinity; Cre	63.0 29.0	5,500	54 24
148	1942	†Coke	Wood	Paluxy, L Glen Rose (Young); Cre L	26.0	1,200	50
149	1930	East Texas	Cherokee, Gregg, Rusk, Smith, Upshur	Woodbine; Cre U	39.0; 58.0	136,000	35
150	1940	†Hawkins	Wood	Woodbine; Cre U	25.0	8,350	100
151	1933	†Long Lake	Anderson, Freestone, Leon	Woodbine; Cre U	63.0 41.0	5,800	24 8
152	1943, 44	New Hope	Franklin	L Glen Rose (Hill); Cre L	43.0-52.0	11,788	15
153	1942	Quitman	Wood	Paluxy; Cre L	41.0	2,300	35
154	1935	Rodessa	Cass	Deese-Young, Hill-Gloyd, Hill-Henderson, Gloyd	38.0-43.0	10,930	20
155	1936	Talco	Franklin, Titus	Paluxy; Cre L	21.0	7,850	35

†Condensate and oil fields; upper figure condensate, lower figure oil.

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THE Petroleum Engineer
OCTOBER 1951

The Engineer's Place in Management*

Engineering is the application of natural sciences; management of that application is an art that requires special attributes

S. F. BOWLBY

THE engineer's place in management is a subject which will involve a rather critical examination of management itself. There have been a great many books written on the subject of management, but I commend to your attention Jethro's advice to Moses in the 18th chapter of Exodus. Moses has successfully led the people into the promised land and is trying to solve all the problems of the multitude himself and getting worked up into a great lather in doing it. Jethro, sitting quietly by a rock, watches this performance for some time, then counsels Moses to the effect that he ought to select a number of able, God-fearing, truthful men to be rulers of thousands, hundreds, fifties, and tens, and bring only the important matters to Moses for final decision. Thus, 3000 years ago, Jethro set the pattern for a successful management — the pattern which today remains unchanged.

My remarks are addressed primarily to our younger technical people, as many of them seem to be concerned about where they are going and how to get there.

First of all, let me make it clear that while engineering and management inevitably grade into one another, engineering is the application of the natural sciences, while the management of that application is an art. The way in which a person may become an engineer is well known, while there is no sure road to managerial success.

When an engineer first stops sending his letters and reports to the general stenographic section for typing and can push a button for a stenographer, or when he has his first understudy, he has made the initial step toward management, because he is accomplishing something through someone else. My definition of a manager is one who accomplishes the desired end through others, using responsibility and authority delegated to him by the owners, to whom he is accountable. These are the three magic words of management—authority, responsibility, and accountability.

And, as many of you aspire to management, let us review some of the basic tenets which many of us have learned, and are learning the hard way. We can best start by taking a look at our own oil industry.

The story of the growth in the petroleum industry during the last fifty years is one of the most spectacular parts of American economic history. In 1900 Russia led the world in crude oil production with 208,000 bbl per day and we were second with 174,000 bbl daily. Today our crude production of more than six million barrels a day is setting an all-time record. In spite of our having produced in the United States five billion barrels of oil during World War II, our reserves are greater than ever before. Again and again the industry has disproved the familiar cry that we are running out of oil. Our domestic crude reserves of 26 billion barrels are 35 per cent greater than they were at the end of 1941. I could go on and on with impressive statistics, but even more impressive to me than statistics is the fact that in contrast with the shortages developing in other basic industries, there is no shortage of petroleum products. Our industry is meeting the demands of the military and in addition is supplying the greatest civilian demand in history. Our pipe lines and refineries can not be designed and built any more easily than the plants for the conversion of other natural resources. The capital investments we must make are among the largest in any industry. Since 1945 the United States oil companies have spent twelve billion dollars on expansion. They have increased their production capacity by 26 per cent. What explains the petroleum industry's ability to keep pace with the times and make these phenomenal advances in the face of repeated dire predictions that we are running out of oil because of our purported inability to find and produce? I think that the answer lies in the persistent application by its managers of sound engineering principles to a business where free enterprise and competition have thus far been unsurpassed. It is true that these men have had keen foresight, but their foresight was based upon all the facts they could marshall, including those accruing to the millions spent in research during that period. Then with the facts in hand the plans have been laid on a sound economic basis. In short, the top managers in the oil business have used the same methodical approach to their problems that engineers are trained to use. Many of these top managers have been lawyers, bankers, or marketing men with no formal engineering background. Nevertheless, they have applied the engineering method in making their decisions.

The term "engineering method" has been used so widely and loosely, that its meaning is vague. Before I go further, let me give an illustration of its use in one typical operation in the oil business and then attempt to define the method.

When a company discovers an oil field, it immediately has the problem

*Given at annual meeting of AIMME, Downey, California, September 13, 1951.

of getting the oil to market. If it is a discovery of any size, the obvious solution to the problem is to build a connection to the nearest pipe line system which can carry the oil to the company's refinery. Management assigns the problem to the engineer for a full investigation. Before he even begins his work, the engineer must be sure that the problem is clearly defined. He must know whether there is only one refinery where the oil can be used or whether there are alternative destinations. Once the problem is carefully outlined, he sets out to gather the mass of data he will need, such as the properties of the crude, the quantities to be shipped, cost of moving the oil by tying into any transportation system already operating, and basic costs for building his own pipe line. When he has acquired all his data, the engineer works out the alternative schemes in terms of capital and operating costs. If he is doing his job properly, he will report on every practical means of getting the oil to a market. Possibly the oil can best be sold at the well to a company which already has transportation facilities nearby. It may be profitable to build a pipe line in partnership with other operators who have production in the area. The engineer finally recommends the plan which will move the oil at the lowest cost over the life of the field. If he decides on a pipe line and the plan is approved, he must follow it through the final design and construction stages to see that the line is built according to specifications so that it will do the job for which it was planned. Once the pipe line is in operation he will check his estimates against actual performance.

From this brief example, we recall that the engineering method consists of five steps: (1) clearly defining the problem, (2) getting all the facts, (3) working out alternative solutions to the problem on the basis of the facts, (4) choosing the best solution, and (5) following through to see that the chosen solution gets the job done. This method is the basis of all sound planning. It is my contention that without such planning on the part of management, the American oil industry could not have had the remarkable growth that we have seen. It would not be capable of fulfilling the needs of the nation as it is doing today.

With the engineering method so widely used by management in making its decisions, it should follow that engineers trained and experienced in the application of this method should make better managers than men who have not been so trained. The oil industry, with its operations becoming more and more technically complex, should be looking to its technical people as the major source of its future managers. I think that it is.

I believe that the management opportunities in the oil industry are unlimited but I hasten to add that the opportunity and demand exist especially for those engineers who develop abilities and interests beyond the solution of technical problems. The engineers who will become managers are those who are continually broadening their outlook to see beyond their own immediate activities.

Having disposed of some of the philosophy of management, how about the job itself? Basically and in its simplest terms, a manager's job is first to decide upon a plan and second, to build an organization to carry it out. Let us see where the engineer stands in this scheme.

The engineer is an excellent planner as far as he goes, but he generally is expected to arrive at his recommendation on the basis of the lowest cost per barrel or the greatest profit per job. His responsibility and usually his interest end there. Carrying on with the example of planning a pipe line, the engineer properly leaves to other departments or outside consultants the questions of what effect existing laws or future legislation may have upon the new pipe line, possible tax complications, the supervisory and personnel problems involved in operating the line, the means of financing construction, and the possible effect of sharp changes in market demand. Yet, when the engineer becomes a manager, he must seek out and consider as basic facts affecting his decision, the experts' opinions on all these facets of the problem and many more. Unless a man in his work as an engineer has had some interest in the effect of legislation, taxes, marketing and personnel problems on the projects with which he has dealt, he is not able to understand and to weigh the opinions of the experts in these fields. When the manager receives the engineer's recommendation to build the pipe line, together with the opinions of other departments, he finds that the engineer's plan is based on certain assumptions, the lawyers are unable to take a firm stand, the tax experts can only hazard a guess. The problem is seldom clear-cut and there are generally contradictory recommendations. The final decision is entirely the manager's responsibility. In determining whether or not the pipe line should be built, he must weigh the risks involved and choose his course, knowing that his success will be measured in profits and not by the assumptions or conditions with which his experts may have hedged their recommendations.

I do not advocate that engineers attempt to assume the functions of the lawyers, the accountants, and the tax men by adding to their engineering proposals a discussion of the problems of these other experts. That would be completely contrary to the principles of business organization. I do urge you, however, to be inquisitive about what happens to your proposals after they leave you. Seek out the opinions of those in other departments who will be consulted before the project is approved. Take a leaf from the lawyer's book and do some extra-curricular reading, as he does when he becomes involved with a case in a field new to him.

So far I have mentioned only that part of a manager's job which involves decision based upon a plan. We are still pretty close to engineering. By far the more important and more difficult part of the task, however, is building and leading an organization to carry it out, because this finally gets to the very heart of management—getting the job done through someone else—the part we know least about.

An organization is composed of human beings, all with different backgrounds, different abilities, different interests. The task of welding all these together in the common weal requires much more of the manager in the long run than anything else. A very capable engineer who was relatively new in a responsible supervisory position once remarked to me that he was amazed to discover that the task of getting engineering work done was so greatly involved with personalities. He said he was completely surprised to find that personnel problems demanded so much of his time. Certainly it was his own fault, but it was also the fault of his company that he had not become aware earlier in his career of the demands and the rewards of good foremanship. Fortunately, the man of whom I speak recognized those demands and met them

The Author

Up in Shell Oil Company's Los Angeles office you will hear that S. F. Bowlby can make a quick and lasting decision. In fact, that back in 1926 he got his start in the oil business that way.

Bowlby was first graduated from the Wisconsin Institute of Technology in '26 in mining engineering, but, after a summer with the Roxanna Petroleum Corporation—now a part of Shell—he entered the University of Oklahoma, where he was again graduated, this time in one of the early classes in petroleum engineering.

Bowlby rejoined Shell and his initial engineering assignment was at Marshall, Oklahoma. He was given the task of determining why Shell's newly drilled deep rotary holes, like others of the day, were not straight. While on the job he conducted some of the early investigations on rotary mud and techniques for measuring the inclination of drilling wells.

In 1935 a special assignment took him to Europe. On returning to the States he became chief exploitation engineer in Houston, and then division manager for Shell in southern Louisiana. Sent to California in 1940, he was in 1946 appointed vice president in charge of exploration and production for Shell's western operations at the age of 41 and in 1949 he was made regional vice president in charge of exploration and production for the West Coast and Rocky Mountains.

successfully, but both he and his company could profitably have been spared his initial perplexity.

The most important ingredient in management, then, lies in its approach to human relations. It may come as a shock to the technically trained mind that the success or failure of an organization may depend on such unmeasurable factors, but it is so. Imagination, enthusiasm, loyalty, aggressiveness, and all the other desirable attributes in an organization are individual traits and can only be developed by careful planning and nurturing on the part of the manager. This is a double-edged affair for the manager since he must join with all other managers in his company, and perhaps even with those in a geographical segment in the industry, to develop sound, long range personnel policies. He must also chart on a day-to-day basis the status of these human relations in his organization in much the same way as a physician charts the temperature of a convalescing patient. It is only with this kind of approach that he may have every opportunity to maintain the desirable individual characteristics in his organization at the necessary high level.

How, you might well ask, does this concern the engineer and the engineering method? The answer, of course, is that it probably doesn't, except that the engineering method seems to be a necessary prelude to good management. I have tried to show briefly why an emphasis on human qualities and their understanding is in the end a requisite of the first order in good management.

Fortunately, our colleges have recognized the importance of human relations by including as requisites in their engineering curricula, courses in the humanities which are designed for the same purpose, namely, to teach people to get along with one another and function as a group.

Most oil companies, in recognition of these needs, have adopted training programs for their new technical people who are just out of school. These programs are in various degrees of formality, some depending upon the progress of the man during the training period and others completely programmed for a period as long as two years. In at least one such program with which I am familiar, the neophyte is given a period of training in every department with which he is likely to be concerned during his later years. The mechanical engineer, for example, is given a short course in field geology, the geologist some experience with the reservoir engineer, and so on. The purpose of such a program, is, of course, to give the trainee an introduction to all the facilities at his disposal, but also and perhaps just as important, it is to give him a feeling of family and, of course, let the family see him and become acquainted with him. Here again we see an attempt to provide a means whereby people may understand one another and learn to work together in harmony. You will recall that during the last war the industry gave its whole-hearted cooperation to the job relations training program which was sponsored by the Government, and which attempted to help every supervisor improve his handling of individuals from the standpoint of human relations. Most companies found that this training paid, and are continuing it in one form or another at the present time.

These so-called trainee programs are only as effective as the individual wishes to make them. Some trainees go through an entire course without realizing that they are supposed to learn as much about getting along with people as they are about the technical and operating aspects of the business which they are entering.

Far too many supervisors, however, still take the attitude that because no one went out of his way to provide a program for their training, they too will permit the young man to learn the hard way. All competent managers now recognize that a person no longer will be content to work solely with the pay check in mind.

Aside from the personal traits which are exhibited by various successful managers in varying degrees, what are the other conceptions of management which are necessary for an organization to function as a well-oiled machine? We have already disposed of authority and responsibility—both must be clearly defined in each step of management. I have also tried to show the importance of human relations, and now lastly, I want to speak briefly about communications which, although third on the list, is of a high order.

With communications in mind, one thinks firstly, I believe, of self-expression. You may have the engineering method well in mind and you may know and appreciate fully the equal necessity for good human relations in your work. Without the ability of self-expression, however, you are in the position of having plenty of gasoline without an engine in which to burn it. It gets you nowhere. The shortcomings of engineers as a group in their ability to express their ideas well in writing and in speaking has brought forth considerable criticism of engineering education from industry and the profession itself. As a result, here too colleges and universities are changing their requirements for degrees to provide time for compulsory courses in English. It goes almost without saying that the success of a young engineer depends upon his capacity to write clearly and not on his ability to apply to principles of mathematics or the natural sciences. This problem of communication is one which bedevils the manager perhaps more than any other single problem outside of human relations. After a great many years' experience, I am amazed to find the number of times in which my ideas are incompletely understood or that I, in turn, incompletely understand the written or verbal ideas that are expressed to me. It is recognition of this problem, however, that will provide the avenue for a solution.

Engineers are assumed to be trained to use their imaginations insolving their problems, but I think that we engineers are too often the doubters and the conservatists. Too frequently when we are asked on opinion of an idea that is completely opposite to our established ways, we are inclined first to think of all the reasons why the idea is impractical. Having thus convinced ourselves that it is impractical, we contribute too little imagination to make it work, and then kill it with a negative recommendation. I am not sure why there is a lack of imagination because it certainly isn't inherent to a technical training. It probably comes from intellectual laziness, and since we are all inherently lazy, it is bound to break out somewhere. Fortunately, it isn't too serious an indictment to the profession, because as we have shown earlier, we have been able to maintain our industry's position in the social economy of our nation at a very high level with ever increasing demands being placed upon us as the years roll by. There cannot be too little imagination used in our business.

Let us not forget, however, that the sure way to progress lies in a positive approach to the new ideas that we generate ourselves, and which come to us from within and without our organization. Too often it has been said that the top executives of an organization must be the planners and creators of new ideas and that the task of the rest of the group is to carry out the plans. The principal flow of ideas, both technical and organizational, should be from the staff to management rather than vice versa. It is only then that the manager can use his own imagination coupled with his advantage of seeing the overall picture to satisfy himself that all approaches have been considered. The engineers particularly are the ones who should suggest the unusual and the unconventional and let management supply the conservatism. Unless an engineer develops a truly imaginative approach to his problems, he will not be adequately prepared to take over the increasing responsibility of management as the opportunity arises.

I think these remarks should be concluded with a few observations which, though related to management, encompass even more. It is well known, for example, that the oil industry rewards technical professions as well as it rewards the less definable managerial ability. While most engineers may aspire to top managerial positions, it is not at all necessary that they do so. There is a great shortage of engineering talent in this country and a good technical man without managerial inclination may be paid just as well and find as much satisfaction in his work as he would in the highest managerial position. To me, then, it is obvious that the first requisite and first ambition of an engineer should be to strive for expert technical proficiency. To put it in the word of Thomas Carlyle "It is our thought that opens up the doors of the world." * *

Freedom is Industry's Need

One of the industry's leaders, Dr. Robert E. Wilson, speaks out against the shackling of progress through government controls

FREEDOM is the one thing the oil industry must have if the progress of people through petroleum is to continue, Dr. Robert E. Wilson, the chairman of the board of Standard Oil Company (Indiana) declared in Tulsa recently.

There must be "freedom to explore where we will, freedom to conduct our research, freedom to seek capital and build plants and facilities, freedom to earn profits with which to finance expansion and maintain our credit."

"We must even treasure the freedom to go broke, or how will we get rid of the inefficient and those who do not serve the public well," he added.

Without freedom from bureaucratic control, oil's service to the people would surely wither. With it, Dr. Wilson is confident that the progress in the oil industry will in the future dwarf its great achievements during the amazing first half of the twentieth century.

Dr. Wilson discussed "Petroleum Spells Progress" before the Oil Forum of the Tulsa Chamber of Commerce at a dinner meeting. At the Tulsa Rotary club luncheon he told of "The Uniqueness of Our Times."

The oil industry is a case history on the advantages of a free enonomy in America. "I don't know where you could find a better example of how a great, complicated system of production and distribution can function in the interest of all the people.

"Do you think we would have that kind of oil industry service today if through the years past the business of this country had been subject to government controls and direction? Could a group of 'experts' sitting in Washington have planned and directed a better sytsem of distribution than has grown up through the competition of thousands of private concerns?

"I ask these questions because I think that the freedom of American business is in serious danger. We may be sure that those who believe in the laying on of hands by big government will take every possible advantage of any emergency, whether real or trumped up. We must be vigilant in guarding our inherited liberties. We must never yield one without keeping a string on it so we can get it back when the world is more peaceful.

"I invite all of you to join with me in a crusade to save freedom not only for the privately-managed, competitive oil companies of the nation, but for all business and for yourselves as individuals." He especially urged oil men to participate in Oil Progress week October 14 to 20 by making speeches on the contribution the progress of their industry has made.

Dr. Wilson provided an acrostic as he spelled out the word "progress" in outstanding examples of the achievements of the oil industry in different areas—"p" for production, "r" for refining, "o" for oil transportation, "g" for geology and geophysics, "r" for research, "e" for enterprise, "s" for sales, and "s" for service.

Production of petroleum in this country is running today over 2 billion bbl a year, the speaker said, or as much as was produced in the first 50 years of the oil industry. Although the U. S. Geological Survey estimated in 1918 that all the oil reserves ever likely to be found in this country would total only 6½ billion bbl, more than 36 billion bbl have actually been produced since then and proved reserves today are more than 26 billion bbl of crude petroleum and several billion barrels of natural gas liquids in addition. "Increases in production have been achieved through the application of science and technology to the discovery, drilling; and producing methods, as well as to every other type of activity." Of the large increase in America's power and heat requirements since 1918, 95 per cent has been supplied by oil and natural gas.

Refining's first great step in progress, according to Dr. Wilson, was the Burton-Humphreys development of cracking at Whiting, Ind., by which the larger molecules in the heavier portions of crude oil were broken into smaller molecules needed for motor fuel. Without the doubling of gasoline yield which that made possible, the astonishing development of the automobile industry could not have taken place. Quality has steadily improved, due to new processes culminating in catalytic cracking.

"The old Burton process," Dr. Wilson said, "took 24 hours or more to make about 35 per cent of gasoline. Today the vapors that are in contact with the finely divided catalyst for only 15 seconds are converted into 50 per cent of gasoline."

Oil transportation is largely responsible for developing all of the modern methods for large-scale handling of liquids, according to the Standard executive. Although other liquids are now moved in tank cars, tank trucks, barges, tankers, and pipe lines, the methods and equipment were developed primarily for petroleum. Pipe lines are oil's special contribution, and are unique in that they do not require the return movement of an empty barrel, car, tanker, or other container.

The various means of oil transportation make it possible to deliver gasoline and other products everywhere in America at an average over-all transportation cost of about 3 cents per gallon, Dr. Wilson said. "In other words, eight pounds of oil is transported a thousand miles by a series of integrated facilities at lower cost than a one-ounce letter over a shorter average distance."

Geology and geophysics are responsible for the ability of the oil industry to keep discovering new oil reserves as fast as they are needed. "A reasonable good price for crude and the depletion allowance, have been necessary to stimulate, finance and expand exploratory effort."

Research and development are being supported by oil companies to a greater extent than by any other industry, according to Dr. Wilson, with expeditures reaching about $100,000,000 last year. Synthetic methods for making liquid fuels are an example of the hundreds of research problems studied, he said. "Even though we don't expect to produce oil synthetically, from coal or oil shale, or much of it from natural gas, for at least 20 years, we are working on such possibilities. We are developing the necessary knowhow, the background of information that we are likely to need some day, and certainly that is excellent insurance for a nation on wheels.

Enterprise is the greatest factor in the development of the petroleum industry —from the independent wildcatter on a shoestring to the dealer who starts a service station on a vacant lot, Dr. Wilson said. The freedom which landowners, wildcatters, and the industry generally have enjoyed in this country accounts for the tremendous progress in development of our oil resources.

Sales and service in the petroleum industry have grown to the point that customers can buy oil products more easily than they can get a postage stamp or a soda, he said. Availability of fuels and lubricants at almost every crossroads has given Americans unprecedented freedom of movement to travel over 400,000 miles of good roads. ★ ★ ★

Fig. 1. Oil film thickness indicator installed on test sleeve-type bearing. Air-core mutual inductance probes are mounted near point at which shaft enters bearing. When alternating current is applied to primary coil, the voltage induced in secondary coil varies with distance of shaft from coil, and may be used to give indication of clearance between shaft and bearing on the cathode-ray tube (right).

Oil Film Thickness Indicators For Sleeve-Type Bearings

In studies of engines and engine lubricants, it is often desirable to measure clearances between shafts and sleeve or journal-type bearings during operation.

It is usually rather difficult, however, to obtain such measurements without affecting the operation, particularly at high speeds. A method recently developed by M. L. Greenough and associates of the National Bureau of Standards for the Navy Bureau of Ships appear to offer a satisfactory solution of the problem. The heart of the new system is a mutual-inductance type of electrical distance-measuring element; variation of the distance of the rotating shaft from two small fixed coils results in a readily measurable variation in the coupling between the coils.

Development of the gage centered around the problem of measuring film thickness in a 6-in. bearing with a radial clearance (difference in radius of shaft and bearing) of about six thousandths of an inch (6,000 microinches). Anticipated maximum rotational speeds were in excess of 10,000 rpm; hence, the gage was designed to make no physical contact with the shaft. Operation in lubricating oil at a temperature of 200 F was another requirement.

Three successful variations of the device have been developed. The models differ in the type and number of probes used, in sensitivity, in suitability for measuring vibratory conditions, and in type of indicating device. A cathode-ray tube is used with one model to provide a continuous picture of shaft displacement, while the other models give distance indications on a dial or meter. Sensitivity is ample; a distance change of as little as 10 microinches — less than a thousandth of the difference in diameter between shaft and bearing—may be detected. In the cathode-ray-tube model a small displacement of the shaft causes a displacement 150 times as great on the face of the cathode-ray tube, and this is by no means the maximum magnification attainable with the system.

In general, measurement of the distance of the shaft from a single probe

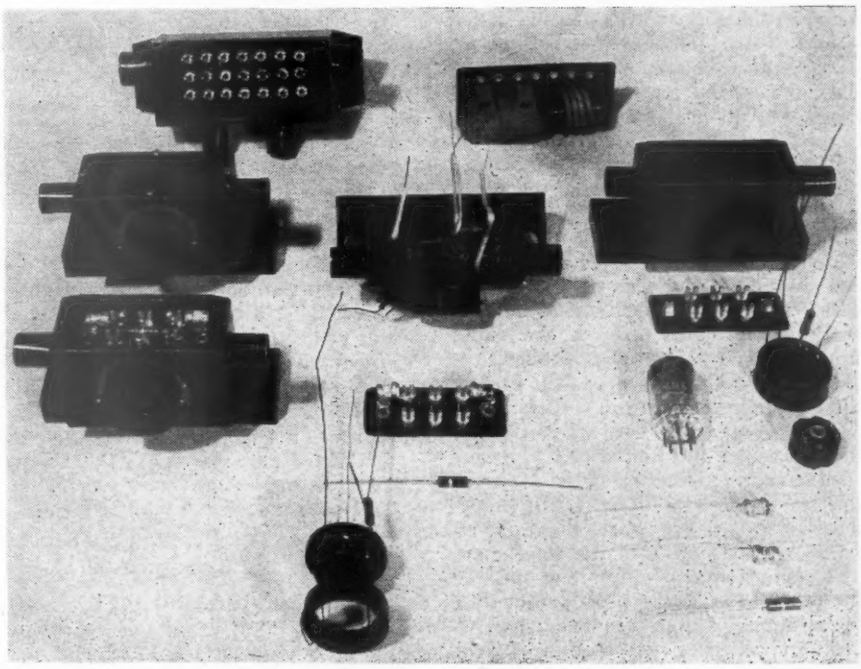


Fig. 2. Details of air-core mutual inductance probe assemblies used with oil film thickness indicator, Model 1. The probe proper (foreground) consists of primary and secondary coil on one-inch diameter form. The probe is mounted in a cored-out steel block, from which it projects (left). Inside each bock is a Type 6AL5 minature voltage-doubler rectifier with associated resistors and capacitors (right foreground).

will not define the shaft-to-bearing distance at all points, even though the shaft be perfectly rigid. From two to six probes are therefore used in the various NBS models. The probes are fastened rigidly to the bearing under study at various locations just outside the point at which the shaft enters the bearing.

Air-core probes at radio-frequency are used in one indicator model (Model 1), while iron-core probes at audio frequency are used with the others (Models 3 and 4). Although the air-core probe system was originally developed at NBS for oil film thickness measurements, the same principle has been used in the NBS electronic micrometer[1] and micromanometer.[2] The miniature iron-core type is an outgrowth of work of previous investigators of oil film thickness.

The two types of probe have much in common. Each probe consists of a pair of small coils—a primary and a secondary—mounted close to each other and close to, but not touching, the surface of the shaft. An alternating current applied to the primary induces in the secondary a voltage dependent on the mutual inductance or coupling between the coils. Because of the effect of the nearby metal shaft on the electrical field of the coils, the coupling, and hence the output voltage, varies with changes in shaft-to-coil distance. The readily-measurable relation between primary current and secondary voltage is thus an index of shaft-to-coil distance, and indicating instruments may be calibrated in terms of shaft-to-bearing distance.

In the air-core probes, which operate at a frequency of the order of 2.5 megacycles, the coils are concentric and approximately coplanar. The nearby metal shaft acts as a shield; the closer the shaft to the probe, the less the coupling between the coils. This shielding action —and, hence, the sensitivity of the arrangement to changes in distance—is optimum if the metal surface is nonmagnetic. For this reason it is desirable, in test installations using the air-core probe, to electroplate the shaft with a thin band of copper centered under the probes.

The coils of the iron-core probes, which are operated at about 2000 cycles, are wound on the legs of a U-shaped form. The nearby steel shaft increases the magnetic flux through the coils; thus, with the iron-core probes, the closer the shaft to the probe the greater the coupling between the coils.

Each of the two types of probes has its advantages and limitations. The iron-core technique is better suited to installations where maximum sensitivity is desired and, furthermore, does not require copper plating of the steel shaft. The radio-frequency air-core probes, on the other hand, make possible accurate observations of high-frequency shaft vibration; these are not possible with the low-frequency iron-core method. The air-core system is also more nearly linear: The input-output ratio is more closely proportional to distance.

Model 1, the air-core unit, is used with a cathode-ray tube to give a polar diagram of the displacement of the center of the shaft from the center of the bearing. This is accomplished by means of four probes spaced at 90-degree intervals and supplied with constant current. The rectified output of each probe is connected to a corresponding one of the four deflection elements, similarly arranged in quadrature, of the cathode-ray tube. The position of the electron beam at any instant is thus the resultant of the four rectified probe output voltages. When the shaft is exactly centered, the electron beam (necessary calibration factors having been introduced electrically) is also exactly centered. When the shaft is displaced from center, both the direction and amplitude of this displacement are depicted on the face of the tube. Should any shaft vibration be present, its amplitude and plane can be readily and accurately observed. Also, any distortion of the bearing from perfect circularity—usually the result of unequal temperature distribution — can be detected. Although in normal operation all four probes are connected to the deflection plates, a selector switch permits examination of each probe separately if desired.

Models 3 and 4—the iron-core models —are used with voltmeters rather than cathode-ray tubes. More sensitive than Model 1, both Model 3 and Model 4 are well suited to precise distance measurements in a bearing test installation after Model 1 has provided an over-all picture.

In Model 3, which uses two probes, the 2000-cycle primary input is automatically adjusted to the level required to give a constant secondary output. The adjusted input is indicated on a meter calibrated in distance units.

Six probes are used with Model 4, which is even more sensitive than Model 3. In Model 4, primary current is held constant while secondary voltage is measured with a bridge circuit of adjustable sensitivity. The bridge circuit is balanced by adjusting a potentiometer dial having an approximately linear scales calibrated in distance units. Model 4, which also uses fewer tubes (three, instead of seven or eight) and is probably the most reliable and accurate of the series, is the culmination of the present NBS-BuShips oil-film-thickness measurement program. ★ ★ ★

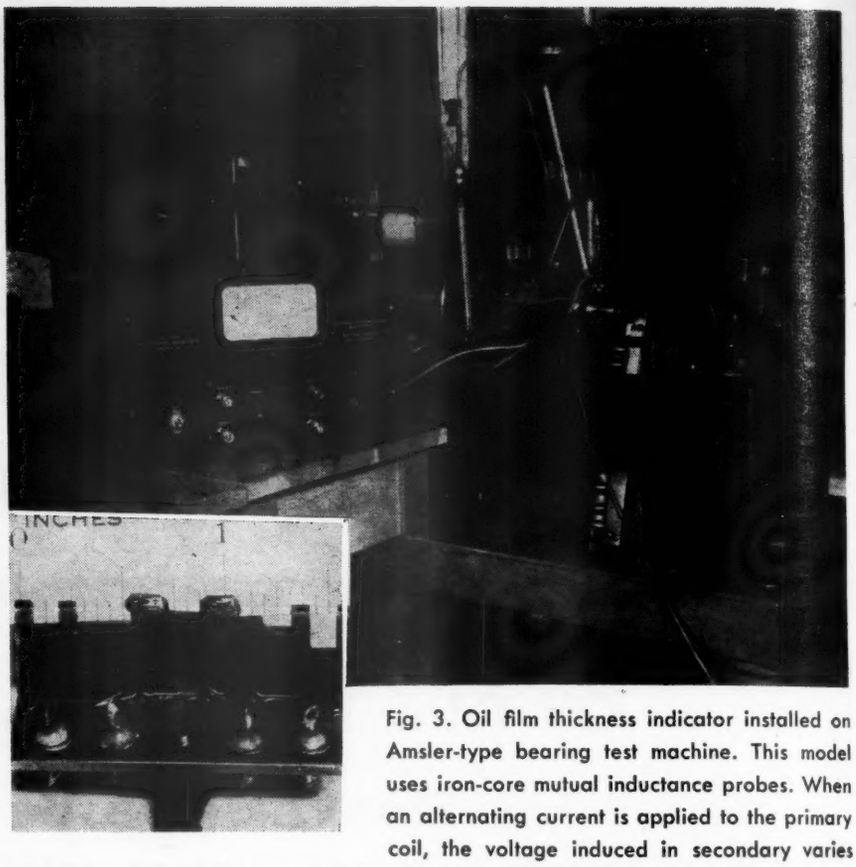


Fig. 3. Oil film thickness indicator installed on Amsler-type bearing test machine. This model uses iron-core mutual inductance probes. When an alternating current is applied to the primary coil, the voltage induced in secondary varies with distance of shaft from coil. Primary current required to give constant secondary voltage may thus be used to give indication of shaft-to-bearing clearance on meter (left) calibrated directly in thousandths of an inch. Insert shows close-up of iron-core mutual inductance probe used in Models 3 and 4 of indicator. A primary and secondary coil are wound around the legs of a U-shaped form. Variation in the distance of the probe from a steel shaft in a bearing-test installation produces the measured change in the coupling between the coils.

[1]Shielding principle provides electronic micrometer, NBS Tech. News Bull. *31*, 37 (1947).

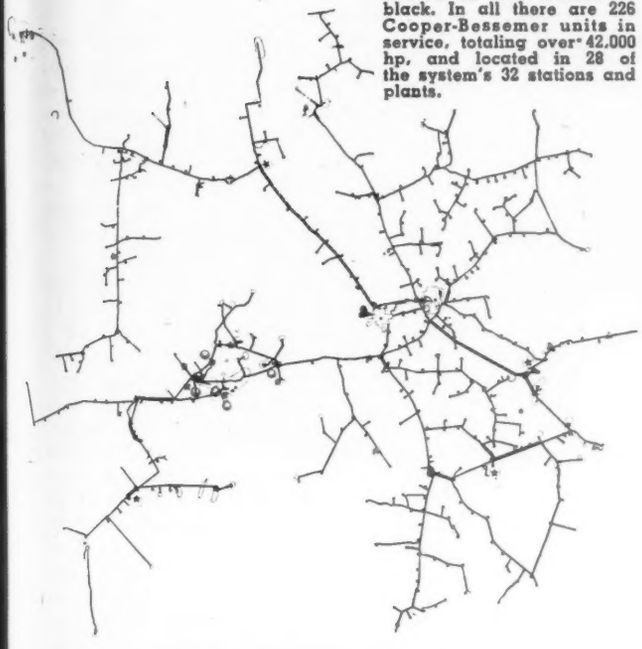
[2]Diaphragm-type micromanometer with electronic pickup, NBS Tech News Bull. *34*, 137 (1950).

Another Example of Efficient Power at Lower Cost

ON THE LONE STAR MAP....

★ Compressor stations
△ Cycling plants
○ Gasoline plants
□ Generator units

....30 years of Cooper-Bessemer power from early horizontals to the latest GMV Turboflows



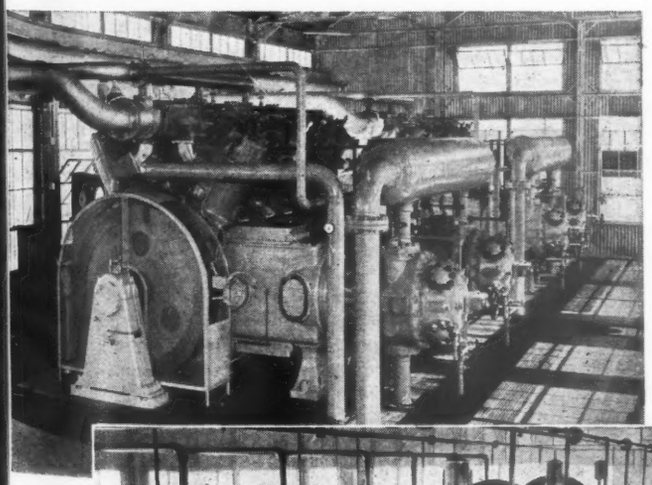
Cooper-Bessemer powered stations and plants are shown in red—others in black. In all there are 226 Cooper-Bessemer units in service, totaling over 42,000 hp, and located in 28 of the system's 32 stations and plants.

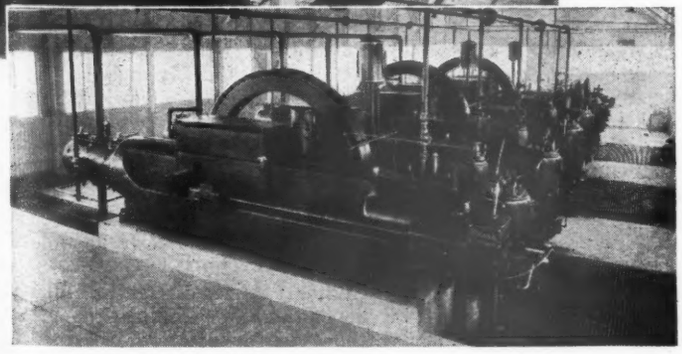
THE map pictures the Lone Star Gas Company's complex system as it is today. It is also evidence of this company's progress, wise management, sound growth . . . and success.

For over 30 years, Cooper-Bessemer has continuously played a major part in meeting Lone Star's power needs of every description . . . engine-driven compressor units, large and small, for gas transmission, cycling and natural gasoline service . . . gas engines of various types for driving auxiliaries and electric generators. Most of the earliest Cooper-Bessemer units, 30 years old and older, are still in regular service, giving efficient, dependable performance!

It's this kind of performance that justifies the confidence Lone Star and other companies show in Cooper-Bessemer products and engineering. It will continue to work to Lone Star's advantage with their latest Cooper-Bessemers—modern GMV Turboflows, for compressor service at lower-than-ever cost.

Below: Two modern, latest type V-angle compressors, Cooper-Bessemer 660 hp GMV-6 Turboflow units, in Lone Star's Gainesville Station.





Left: These Cooper-Bessemer 170 hp Type 75 horizontal compressors, installed in Fox Station 22 years ago, are still in continuous service.

New York, N. Y. Washington, D. C. Bradford, Penna. Parkersburg, W. Va.
San Francisco, Calif. Houston, Dallas, Greggton, Pampa and
Odessa, Texas Seattle, Wash. Tulsa, Okla. Shreveport, La.
St. Louis, Mo. Los Angeles, Calif. Chicago, Illinois Caracas, Venezuela

The **Cooper-Bessemer** *Corporation*

MOUNT VERNON, OHIO — GROVE CITY, PENNA.

This K-360, 1½ yd shovel has its work cut out for it on this rock job. But the job will proceed quickly with the oiler on his toes keeping the machine at top operating efficiency.

Shovel Crane Service

A. E. YORK*

THE international situation and America's increasing defense efforts have created abnormal demands for construction equipment. Among those in the greatest demand are power cranes and shovels.

This unprecedented call for new power cranes and shovels has also accelerated the demands upon equipment already in use. As long as the present shortage of new equipment for normal civilian requirements exists, it becomes increasingly vital to keep existing equipment in the best operating condition. In times like these, delays and shutdowns become especially costly, and can usually be prevented by planned care and preventive maintenance.

The most important periods in the lifetime of a crane or shovel come when they are first placed in service, and the period immediately following when the customer is becoming accustomed to the machines. That's why it is essential that this piece of expensive equipment be started off properly by qualified servicemen.

*Link-Belt Speeder Corporation. York has been in shovel-crane business for 12 years—all of that time with Link-Belt. He spent two years with the Army Engineers and upon return to civilian life he was named service manager for Link-Belt in 1946.

Too often, a new shovel or crane is deadlined because of improper care and lubrication after the machine has left the factory. In many cases the problem of too much grease is almost as serious as too little lubrication. As the danger connected with lubricating certain points is covered at the time of delivery, the customer should see that the information reaches the proper personnel.

One important detail to remember is the periodic examination of lubrication tubes. Too often it has been discovered too late that a grease tube has failed or become clogged, and that grease was not reaching its intended goal. When that happens, some bearing will fail for lack of grease, which may also result in damage to a shaft or other important part. Replacing such shaft or part is often difficult and may result in a long, costly shutdown that could readily have been prevented by careful maintenance.

Clutches should be inspected closely to make sure they are maintained in good condition and adjustment. It should be determined whether or not the clutch is wearing properly. Linings should be examined closely and kept clean and free from grit and other foreign particles to eliminate scoring of drums. Center pins should be checked and tightened as needed. Drive chains should be kept in adjustment, and sprocket chains examined for undue wear. Bushings should be watched to avert shaft scoring. Engine filters must be changed at specified intervals to safeguard the power plant of the machine. Good maintenance also entails the advance ordering of needed parts. Many parts, such as linings, cables, dipper and bucket teeth, and the like, are essentially wearing parts, and must be replaced periodically.

Machine cleanliness is paramount in good care and maintenance. Good "housekeeping" is conducive to good care and maintenance, and a well cared for machine is invariably also a clean machine. Pride in keeping the machine clean will instinctively encourage the operator to pay close attention to the proper care and mechanical condition of his machine, the importance of which cannot be stressed too strongly.

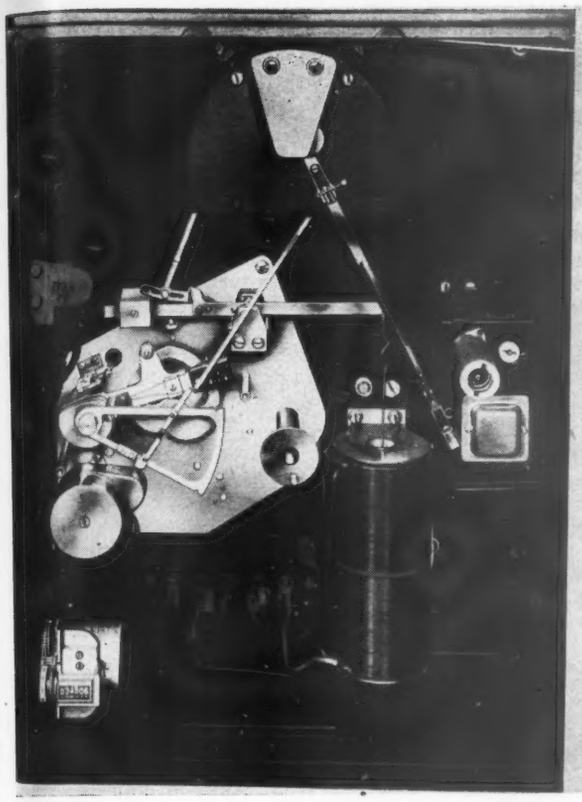
Periodic cable inspection is vital in all machines. A frayed cable should be promptly replaced, particularly if it is a load-carrying cable. Although it may be subjected to little actual running wear, the boom hoist cable—which is a load-carrying cable — also should be inspected frequently, as its failure could well result in serious damage or even personal injury. In these inspections, all cable connections should also be checked.

Overhaul jobs, which in normal times may have been undertaken without too much forethought, assume major proportions in times of emergency such as the nation is currently undergoing.

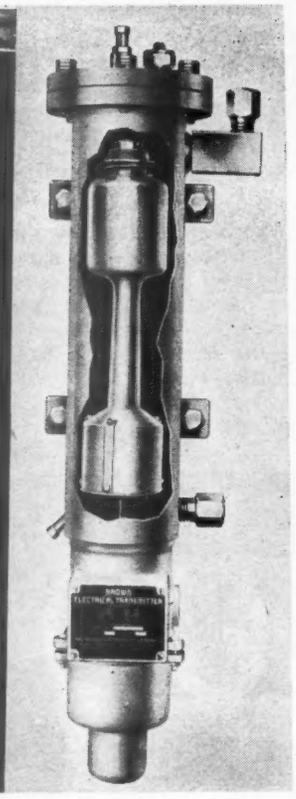
First step in such an overhaul job must be to determine the extent of the job. This calls for a detailed study and examination. Ordering additional material after the original order has been sent in can be avoided by making a careful first estimate. Definite shipping dates should be received. Better yet, no equipment should be disassembled until all material is on hand. Not too infrequently, a small item out of a large order can tie up a major repair job because of some supplier's inability to live up to a promise.

Local facilities for the job to be done must be explored to make certain the job can be completed in the least possible time. If local sources prove inadequate, improvisations can usually be made. Often it is wiser to move the equipment nearer to the proper facilities for repairs and overhaul.

With the present material shortage at hand, consideration should be given to rebuilding parts, especially those that can be welded to return to original dimensions. Track sprockets, track rollers, track shoes—all can be rebuilt with hard surface rod to extend the life of these parts. Bores that have been worn oversize, can frequently be welded and rebored to standard size so as to make future replacements easier. Shafting—depending upon application—can sometimes be metal-sprayed satisfactorily. When possible, a plating process should be used to salvage shafts. ★ ★ ★



Interior of evenly graduated flow meter.



Cutaway view of meter body.

NEW FLOW METER

ENGINEERS of the Brown Instruments Division, Minneapolis-Honeywell Regulator Company, have developed a new flow meter, which, they state, includes such important advantages as an evenly graduated meter scale and electronic integration. It is available either as a mechanical flow meter with integral recorder, or as an electrical transmitter to be used with a Brown inductance bridge receiver.

The new meter is of the differential type, readily installed on a flow line. The meter body is mounted in a convenient location near the line, and the differential pressure lines from the orifice (or other primary element) are piped into the half-inch SPT connections provided on the meter.

For electrical transmitting meters, a three-conductor cable is run between the meter body and the remotely mounted receiver. The new meter is supplied in three ranges: 53, 119.25 and 212 in. of water, and for 750 and 1500 psi static pressure. For dry calibration the three ranges are slightly greater.

Flow meters with evenly graduated scales possess several distinct advantages over the conventional square-root type of flow meter that make them particularly useful in flow accounting applications. Among the most important advantages of evenly graduated flow meters are their suitability for integrating operation and their readability throughout their entire range of calibration.

When integration is employed, it is preferable to use a flow meter with an evenly graduated scale. The comparatively small pen movements available at the low end of the scale on square-root meters make integration less accurate as the measured flow decreases. On an evenly graduated meter, however, a given flow change produces the same pen movement on any part of the scale, providing ample pen motion for positioning the integrator over the entire chart range.

Device Simplifies Integration

The electronic integrator incorporated in the new flow meters considerably simplifies the integrating action in flow measurement. The entire integrating mechanism comprises but three major assemblies as follows:

1. A scanning unit that checks the flow rate, as evidenced by the meter pen, 12 times each minute.
2. An electronic detector relay that is actuated by the scanning unit and that operates the counting mechanism.
3. A motor-driven counter assembly that totalizes the successive output impulses from the detector relay, thereby performing the integration of the flow measurement.

Unit Construction Employed

Illustrated is the interior of the new Brown evenly graduated flow meter recorder with the chart plate and scanning unit protecting cover removed. Unit construction is employed in the flow integrator to facilitate maintenance and render the various assemblies individually replaceable. Assemblies are connected together by pre-formed cables equipped with quick disconnect fittings.

Scanning Unit for Integrator

An electronic circuit is employed to detect the pen position. This feature eliminates placing a load on the flow pen. It also eliminates complicated gearing, pawls, friction drive wheels, and the like.

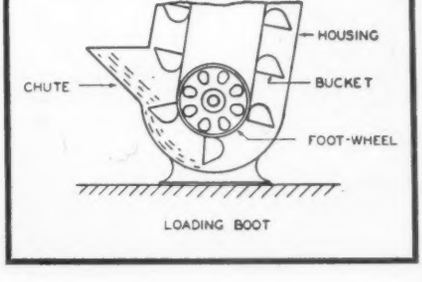
The electronic unit comprises (1) a lightweight vane that is positioned by the meter pen through a mechanical linkage, and (2) dual oscillator coils mounted on an arm driven by a precision-made cam. In operation, when the leading edge of the vane is intercepted by the coils, the electronic detector relay is energized, and the counter motor is permitted to operate.

The counter motor operates so long as the oscillator coils are intercepted by the vane, and stops instantaneously when the vane and coils are separated. Operationally, the oscillator scanning coils "feel" the vane position (which is a direct function of the pen position) 12 times per minute. This rapid scanning rate assures accurate integration not only under rapidly changing flows but also under low flow conditions.

Direct Reading, Six-Digit High Speed Counter Employed

The direct reading six-digit counter is driven by an accurate timing motor. By totalizing the successive output impulses, the counter unit performs the integration. The counter driving gears are so designed that the integrator factor is always a decimal, such as 1, 10, 100, or

FIG. 1.



1/10, for any of the standard evenly divided charts. Each digit on the counter will represent 1, 10, 100, or 1/10 units of flow depending on the maximum flow range of the instrument.

The counter turns from 200 to 1500 counts an hour (when the flow is in hourly units). This high counter speed results in the integrator being sensitive to small changes in flow rate. For example, on a steam meter with a maximum range of 10,000 lb per hour, each digit on the last wheel of the counter will represent only 10 lb of steam. This high counter speed is also of value in checking and calibrating the integrator.

A seventh wheel is also provided to facilitate calibration. This wheel, mounted to the left of the six-digit counter, turns from 720 to 15,000 times per hour, depending upon the chart range. With the fast counter, calibration can be checked to a very high degree of accuracy in a matter of minutes.

Principle of Evenly Graduated Flow Measurement

The heart of the new evenly graduated meter is a characterized bell. This bell senses the differential pressure created by a fluid flowing through an orifice or other primary element, and moves in proportion to the square-foot of this differential. Functionally, the bell is a hollow float whose inside surface is shaped to give a square-root response to differential pressure changes. It is housed in the meter body, with the open end sealed by a pool of mercury at the bottom of the meter body. The mercury also serves to support the weight of the bell and attached parts.

The high pressure line from the orifice goes directly into the meter body and applies pressure against the outside of the bell. The low-pressure line enters the meter body through the low-pressure tube, which, in turn, passes through the mercury pool and on up inside the bell. Thus, the bell floats in mercury with high pressure on the outside and low pressure on the inside, with the mercury pool providing a seal between the two.

As flow starts through the primary element, the differential pressure created causes the mercury to assume a new level. The inner level becomes higher than the outer in proportion to the amount of differential pressure. Simultaneously, the bell moves downward in the meter body by an amount proportional to the square-root of the differential.

Overload and Air Release Provisions

The meter is protected against overload in two ways. First, a large overload chamber is attached to the bell just above the upper end of the calibrated section. This chamber has sufficient capacity to prevent the mercury level from reaching the top of the low-pressure tube should excessive differential pressure force all the mercury into the normally low-pressure region. Secondly, a sealing disc inside the overload chamber closes off the low-pressure tube opening if the bell moves below its normal operating travel. This provision affords a positive seal that prevents the measured medium from circulating through the meter body.

Means for readily releasing entrapped air from the bell and meter body (when measuring liquids and steam) have been provided. Venting is accomplished by simply removing the body-cover flange and opening a small valve in the top of the bell. The cover is then replaced and the meter body is vented by unseating the fill plug in the cover. If reasonable care is taken, the second operation can be performed under pressure.

Start-Up and Maintenance

After piping and wiring connections have been made on a new installation, the meter is adjusted to compensate for any slight differences between the amount of mercury present and the quantity used in factory calibration. For this purpose, a check weight is provided, which is calibrated to produce a certain meter reading when placed on the bell. As no water column is required, field calibration is simplified. After this weight has been set in place, the transmitting coil zero nut of the electric type meter is adjusted to produce the proper meter reading. The weight can then be removed, and adjustment is completed by resetting the zero stop. In similar fashion, the mechanical type instrument can be adjusted. * * *

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This ruggedly built instrument of laboratory accuracy is ideal for quick checking and for continuous recording of Specific Gravity of liquids under line pressure. Changes in Specific Gravity of sample are recorded with a very minimum of time lag. Foreign liquids and gases are automatically purged from sample. No moving joints or stuffing boxes to cause friction or leakage. Temperature corrected, this precision instrument is adaptable to high pressures. Hundreds are in daily use in plants and refineries of major companies. Also available as a controlling instrument. Send for bulletin No. 111A.
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To gain greatest possible gas thru-put within the least floor area, Panhandle Eastern Pipe Line Co. is expanding the facilities of its main line stations at Tuscola, Ill., Zionsville and Edgerton, Ind. with 8 Clark HLA, 2000 bhp, Super 2-Cycle, High Compression, Gas-Engine-Driven Compressors.

And the first of these units, in operation since January 1951, is truly a milestone in heavy duty compressor history! For, with this installation began a new era of opportunities for gas transmission pipelines and other applications: Unprecedented savings in space, resulting from increased power per square foot of floor area; unmatched fuel economy resulting from Clark high compression design; unrivaled simplicity and accessibility resulting from vertical, in-line power cylinders.

Being the first to install the Clark HLA, it's only natural that Panhandle Eastern would be among the first to take advantage of another recent Clark development, too . . . the air cooled compressor cylinder, thus assuring greatest attainable compressor efficiency.

With more than 100,000 bhp on order or being installed by the country's leading pipeline companies within a few months after its introduction, the position of the HLA as the leader in its field is clear.

Complete information on the four models, covering a range of 1250-2500 bhp, is obtainable in New Catalog No. 113, and from your nearest Clark representative.

COMPRESSORS

CLARK BROS. CO., INC. One of the Dresser Industries OLEAN, N. Y.

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BUENOS AIRES • CARACAS, VENEZUELA • LIMA, PERU • BOGOTA, COLOMBIA • NEW DELHI, INDIA

Cutaway model of Boeing lightweight gas turbine.

Small Gas Turbine Has Wide Power Potential

A NEW engine with impressive potentialities is the small gas turbine made by Boeing Airplane Company. Still in the testing stage for many uses and for performance in many capacities, the gas turbine has already gained production contracts for Navy ships and is under consideration by the Army and Air Force also. The general market will have to wait until military needs are filled.

Boeing executives believe that the small gas turbine opens a new era in mechanical power derived from petroleum products; cheap, reliable, and lightweight power that may well affect more people and reach higher dollar volume in our industrial economy than has the current revolution in aircraft powerplants.

One of the first tests of the gas turbine was made in a Kenworth truck. It traveled more than 5000 miles, carrying loads up to 68,000 lb over trucking routes in the Cascade Mountain range.

The gas turbine is similar to the jet airplane engine in its general design but the tremendous power developed is harnessed by a secondary turbine to turn a shaft rather than being exhausted as a jet thrust. It is said to operate more quietly than a conventional diesel truck of equal power.

In the tests made the engine used liquid fuels, including kerosine, gasoline, diesel oil, and even heavier oil up to Bunker C. The 200-lb gas turbine (Fig. 1) with a rating of 175 hp compares in power output to diesel engines weighing 2000 to 3000 lb, Boeing engineers state. This is with a minimum fuel consumption using diesel oil of 1.25 lb per brake horsepower per hour.

P 807.

Fig. 2 is a diagrammatic sketch illustrating the basic components of the engine and showing how the assembly operates. The first turbine wheel drives only the compressor. Fuel is sprayed into the two burners receiving compressed air discharged from the compressor. Only a portion of the air is burned, less than one fourth of the total compressor flow, actually. The rest is mixed and heated with the burning fuel and air so that the average temperature reaching the turbine is reduced to 1500 F, whereas, the temperature of combustion at the "core" of the burner is about 3500 F.

This is the basic feature or invention that made the gas turbine possible; that is, the idea of utilizing steady combustion at 3500 F by surrounding the flame with cool air so that no metal parts have to withstand this high temperature. Of course 1500 F, the temperature after mixing, is still high, and special alloys are required to withstand the centrifugal stresses in the turbine shell at this temperature.

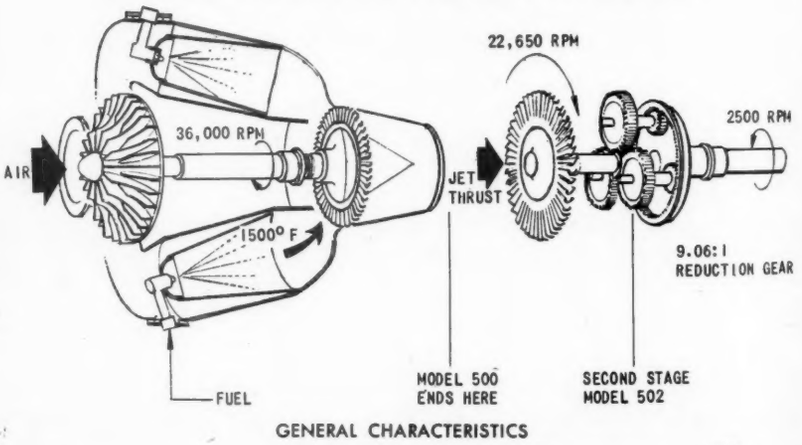
Many changes have been made since Boeing began research on the fundamentals in 1943. The idea came from jet engine research, when a midget-size jet engine was geared to a shaft to produce the first gas turbine.

The simplicity of design, the light weight, small volume, and torque characteristics (it provides greater instead of less torque when the speed is reduced) are advantages named by Boeing of the small gas turbine over the conventional reciprocating engine.

Its use of a wide range of fuels (although it must be adjusted for each) is also important.

The small gas turbine, still in the future for regular markets, appears to be one of the strong indications that radical changes in supplying power for commerce and industry and war are close upon us. ★ ★ ★

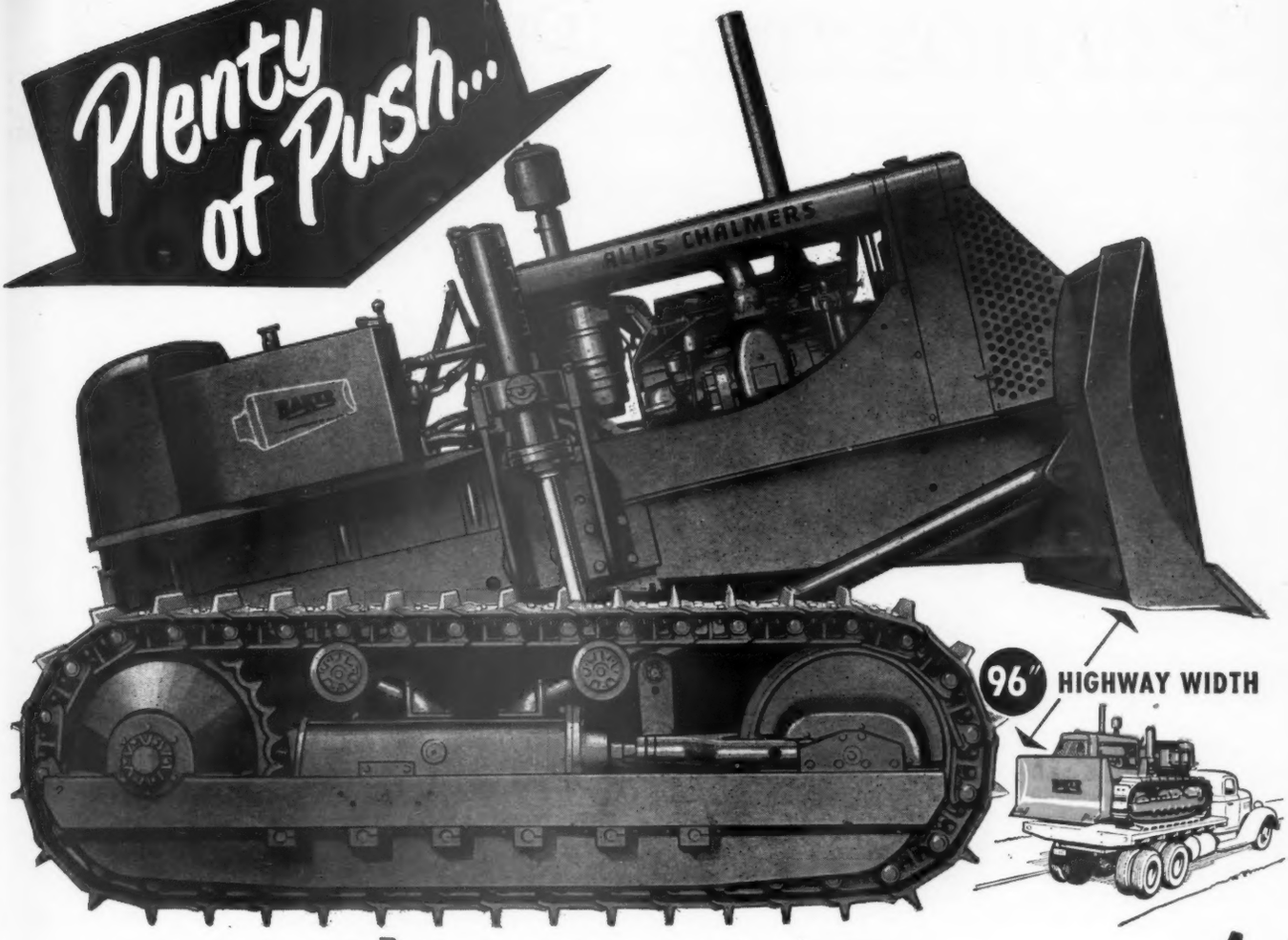
Model 500 and Model 502. Performance characteristics.



GENERAL CHARACTERISTICS

	500	502
Weight	117 lb	195 lb
Power Actually Produced	170 lb thrust	180 HP
Probable Future Developable Power by Detail Refinement	210 lb thrust	220 HP
Full Throttle Fuel Consumption—Now	1.2 lb/lb thrust/hr	1.28 lb/hp hr
Full Throttle Fuel Consumption (Probable Future)	.9 lb/lb thrust/hr	.90 lb/hp hr

Plenty of Push...



...but NO Push Beams!

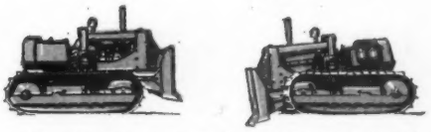
Push beams are eliminated *entirely* in the revolutionary new *highway wide* Baker 9-X 'Dozer. Bulldozer and engine frame form an integral unit. Blade responds instantly through double-acting cylinders, which raise and lower tractor-dozer unit. And tying it all together, making it work, is an entirely new design in *stabilizer bars* and *horizontal bearings.*

Here are some of the advantages for many jobs:

HIGHWAY WIDE: Width only eight feet—96 inches—exactly the same as standard highway trailers. Haul the Baker 9-X anywhere, anytime, *day or night,* with NO SPECIAL PERMIT.

PLENTY OF PUSH: Mounted right on an Allis-Chalmers HD-9, the moldboard is 6 inches higher than standard blades to provide almost same blade area, for plenty of push, plenty of capacity—with the famous Baker "move-more-dirt" moldboard curve.

IN FAST, OUT FAST: Steeper angle of approach on the blade because of close coupling. You can get in fast, out fast,



with the Baker 9-X Dozer. Makes it the ideal unit for jobs like slush pits; *makes it the most practical dozer* of all for small-home basements.

FULL LIFT, FULL DROP—Maximum lift is a full 37 inches, maximum drop is full 13 inches.

SURE-FOOTED CENTER OF GRAVITY: Even with blade at maximum lift, center of gravity is 6⅜" behind second roller—not more than a few inches ahead of center of gravity in unmounted tractor. YOU CAN LEAVE BLADE ON FOR DRAW BAR WORK.

LIGHTER: Takes 1,150 lbs. less steel to build . . . costs less to buy. See the new, revolutionary *highway wide* Baker 9-X Bulldozer—another triumph of Baker, Allis-Chalmers engineering cooperation, at your Baker, A-C dealer.

PETROLEUM PROFILE

DOUGLAS HAYES GRAHAM
President
Dunlap and Graham, Inc.

DOUGLAS HAYES GRAHAM, much better known to his friends as "Doug," was appropriately enough born in the little town of Friendship, Kentucky, and still retains in his speech an intriguing touch of that old bluegrass intonation. His father was a drilling contractor in the boom days of Spindletop so it was only natural that young Doug too should sooner or later fall a victim of the petrolic urge. His first association was with Graham senior in the drilling of a series of wells for the Corsicana Petroleum Company, now Magnolia. Later he garnered further experience in the rugged ways of the oil men at famed Burkburnett and Wichita Falls, and by the time he was sixteen years old was already a seasoned tool dresser. He foraged around the oilfields of Oklahoma for a while and finally found his way to Tulsa where he attached himself to the Oil Well Supply Company, the preliminary step in many a scintillating oil career. Thence he skipped shortly to Bovaird Supply Company at Sapulpa, but this was just at the time that the Ranger excitement was at its height and he found himself unable to resist the lure of the operating end of the oil business. For the next several years he functioned as drilling superintendent for various outfits in Texas and Illinois and then in 1923 struck out for Long Beach, California, where he organized an institution for the purchase and sale of used oil well equipment. It prospered and, indeed, Doug is still the owner of a depot in Bakersfield that is an offshoot of this first California venture.

Dunlap & Graham, Inc., of which he is now president and joint owner, was formed in 1939, and has been most successful. The firm has in operation at the present time six drilling rigs, one in Peru, and is a well equipped, capably administered organization that has an enviable reputation among operators in all parts of the country. In the meantime, Doug and his partner, D. D. Dunlap, have acquired a bit of production here and there and are fairly well supplied with this world's goods.

It is probable that Doug's most enjoyable diversion is associating with oil people. He is an interesting and entertaining conversationalist and an expert barbecuist, and he is never happier than when hosting a group of oil people at his Long Beach home. On such occasions he dons an apron and linen hat, presides over his outdoor barbecue with all the skill and finesse of a Parisian chef, and practices both his hobbies with an enthusiasm that is distinctly contagious. He is an experienced flier and enjoys frequent journeys in his company plane to the remotest work camps of his drilling crews. He also likes fishing—deep sea or stream—and by all accounts casts a mean line when he indulges his Waltonian propensities.

Doug is a director-at-large of the American Association of Oilwell Drilling Contractors and a former vice president for California. He is a popular member, too, of the Petroleum Club of Los Angeles, and of the Petroleum Production Pioneers, and is a pleasing speaker at various industry functions. He is a director and one time treasurer of the Children's Home Society of California, and appears, indeed, to keep himself busied in many altruistic and altogether worthwhile enterprises. He has an inexhaustible fund of colorful industry anecdotes from which he draws very appropriately when the occasion requires; he is definitely what is known in petrolic vernacular as "a solid citizen."

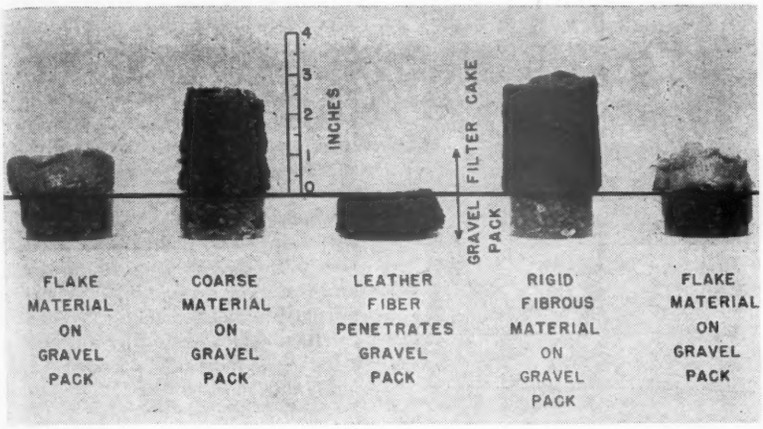


FIG. 1. Cake formation of several lost circulation additives on gravel packs. This photograph depicts the manner in which several types of lost circulation materials are deposited onto gravel packs. The center item shows how the leather fiber penetrates the gravel beds approximately one inch, whereas the other materials shown merely accumulate on top of the gravel pack.

LOST CIRCULATION

A NEW FIBROUS MATERIAL FOR ITS CORRECTION

E. E. GLENN, JR.,* and R. JENKINS*

Abstract

It is the purpose of this paper to describe the performance of a new fibrous material, prepared from leather, in sealing off highly permeable zones causing lost circulation during drilling of wells. Laboratory tests have shown that this material is superior to other substances tested in plugging both consolidated and unconsolidated, highly permeable beds. Leather fiber has been field-tested in a number of wells in which lost circulation was being experienced. The leather fiber was found to be more effective than any other lost circulation additive employed in these wells. Specific examples of these tests in drilling wells are cited.

ONE of the more serious problems frequently encountered during the drilling of an oil or gas well is the control or prevention of the loss of drilling fluid to formation voids, commonly referred to as "lost returns" or "lost circulation." This loss of drilling fluid may be rapid or it may be relatively slow; however, it is not to be confused with the slow loss of fluid to the formation resulting from the normal filtration of mud solids on the well bore.

The problem of lost circulation was apparent in the early history of the drilling industry, being magnified considerably by the continued necessity for drilling to deeper formations. Millions of dollars are expended annually by the petroleum industry in combatting lost circulation and its subsequent detrimental effects, such as loss of rig time, stuck drill pipe, blow-outs, and, frequently, complete abandonment of expensive wells.

The strata considered in this paper to be so-called "thief" formations or loss zones include those containing fissures, cracks, and crevices, as well as porous, highly permeable sandstones and gravel beds. The problem of losses into cavernous type zones is not considered here, since it does not seem reasonable to expect a fibrous material, the principal subject of this paper, to be effective in such cases.

There are many substances that have been used in attempts to restore circulation in drilling wells. These include fibrous materials, flaky materials, a variety of granular materials containing wide particle size ranges, and bulky materials such as cottonseed hulls.

Considerable work is reported in the literature[1, 2] on the use of fibrous materials in combatting lost circulation. In laboratory tests most of these materials are shown to be rather rigid in structure and are filtered out of the mud, to form a relatively thick filter cake (see Fig. 1). When this situation occurs in the drilling well it is, of course, untenable if the hole is near "gage" as the thick cake will be totally or partially removed from the well bore during round-trips for bit exchange, thereby opening up the loss zone. Under more serious circumstances the cake may build up to such an extent as to stick the drill pipe. In addition, laboratory tests indicate that in many cases the coarse type of fibrous material does not function in the desired manner for a lost circulation additive but is filtered onto the formation surface as a porous "brush heap" and continues to permit easy passage of the mud into the formation.

Several types of flaky lost circulation additives have been described[3, 4] and are commercially available. These materials, in some instances, have the disadvantage of forming a rather thick cake (see Fig. 1). Although not as thick as that from a rigid type of fibrous material, when such a cake from flaky substances is deposited on the well bore it is still susceptible to removal by movement of the drill bit. Cellulose-type flaky materials are also subject to bacterial attack and on occasion require

*Magnolia Petroleum Company, field research laboratories, Dallas, Texas.

The Authors

E. E. Glenn, Jr., is a senior research technologist in Magnolia Petroleum Company's production research laboratory at Dallas, Texas. He received his B.S. degree in petroleum engineering from Louisiana State University, and his M.A. and Ph.D. degrees in physical chemistry from the University of Texas. He served four years in the U. S. Army from 1941 to 1945 and joined Magnolia in 1950.

Rodman Jenkins is a research technologist with Magnolia. He completed work for his Ph.D. degree in chemical engineering at California Institute of Technology in 1949, and received his B.S. and M.Ch.E. degrees from the Massachusetts Institute of Technology and the University of Delaware respectively. He was formerly employed by E. I. du Pont de Nemours and Company.

EXCLUSIVE

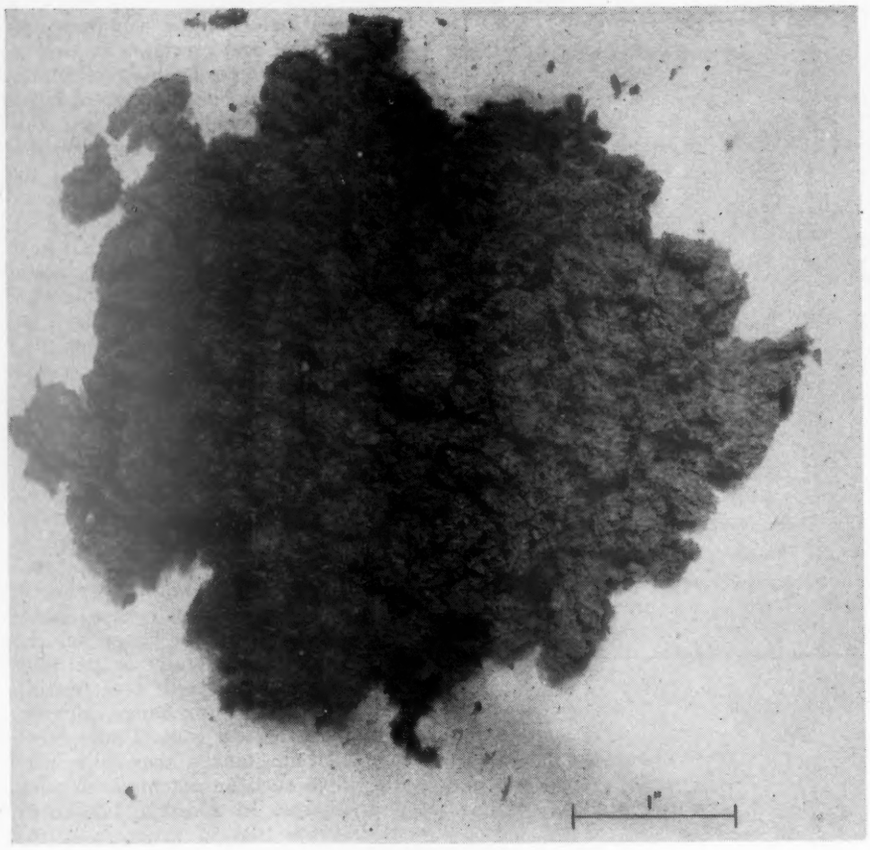


FIG. 2. Photograph of dry leather fiber.

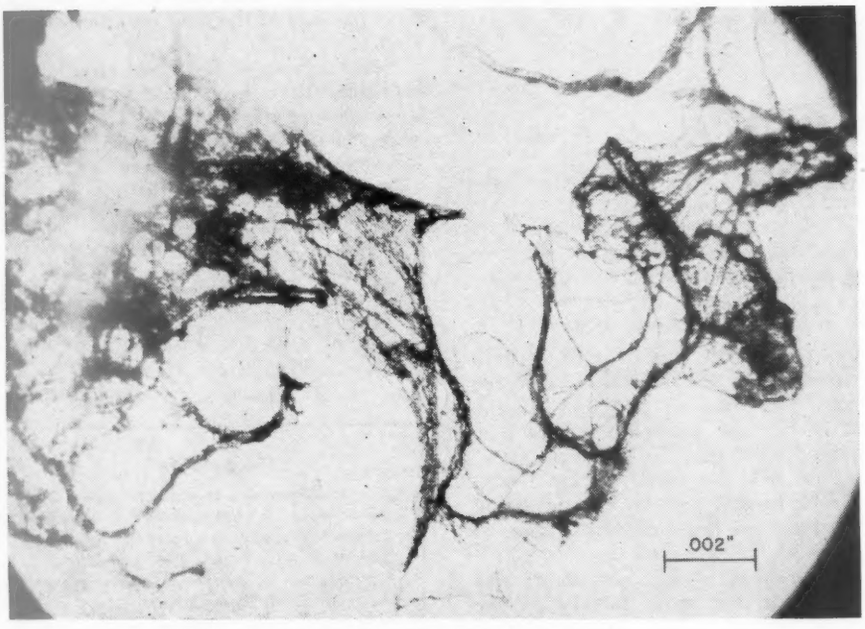


FIG. 3. Photomicrograph of wetted leather fiber.

control measures for prevention of fermentation.

Granular materials having a wide particle size distribution have been shown to be fairly successful in restoring lost circulation.[3,4] These materials, however, are usually rigid and some are actually fragile. The crushing and abrading action of the pump and bit orifices probably results in severe reduction of the larger sized particles which also limits the size of opening the material is capable of bridging.

A recently developed fibrous material prepared from leather, known commercially as "Leather Floc,"* has been shown by extensive laboratory and field tests to possess a number of properties that are highly desirable in a lost circulation material. A photograph of this material is shown in Fig. 2. The fibers, which are derived from leather, are very strong and exceptionally pliable. In a drilling fluid, the fibers are observed to be twisted and entangled in clusters much larger than the individual fibers as shown in a microscopic projection in Fig. 3. These clusters are very effective in bridging over large-size pore openings and in providing a mat of low permeability on which a normal mud filter cake may be formed. Further, when wetted by either water or oil, the leather fibers become very pliable and conform very closely to the roughness of the formation surface. The fiber mat so formed is very thin and does not contribute to the formation of a thick filter cake that could be easily removed by action of the pipe or bit in the hole.

*"Leather Floc" is manufactured by Lorum Fibre Company, Inc., New York 18, New York, and distributed by Magnet Cove Barium Corp.

Experimental Work—Lost Circulation Additives

Plugging Tests on Highly Permeable Gravel Packs. A testing unit illustrated in Fig. 4, similar to a standard high-pressure wall-building unit, was used to test the effectiveness of a number of additives for stopping mud flow through a highly permeable bed. The mud chamber was a stainless steel cylinder 24 in. long and 2 in. in diameter, having a capacity of 1000 cc (1.05 qt). The cap of the tester was equipped with a pressure connection and the bottom plate with a gate valve. The "thief" formation used in these tests was a 4½ in. column of 6-8 mesh gravel that was packed into the bottom of the 24-in. cylinder and supported by a piece of 8-mesh hardware cloth fitted into the bottom plate.

The test procedure used was to add the sized gravel to the cell containing about 200 cc of water until the desired depth of gravel was obtained, while tapping the cell to assure closest possible packing of the gravel. The water was drained until its level was at the top of the gravel bed. This procedure yielded a bed with a permeability of approximately 7600 darcys. A weighed portion of each of the 21 additives to be tested (in most cases, at a concentration of five pounds per barrel) was added to a given amount of either a fresh water or a lime-base mud, and the mixture stirred for 10 minutes. The mixture was carefully poured into the cell so as to cause a minimum disturbance near the face of the filter medium, and 100 psig nitrogen pressure was applied at the top of the cell. The bottom valve was opened and the volume of mud that passed through the gravel pack before the formation of an effective filter cake was measured. In this paper this quantity of mud will be referred to as the "surge loss." The surge loss period was usually less than 20 seconds. Slow, dropwise filtration after the formation of an effective filter cake indicated that water loss still occurred as

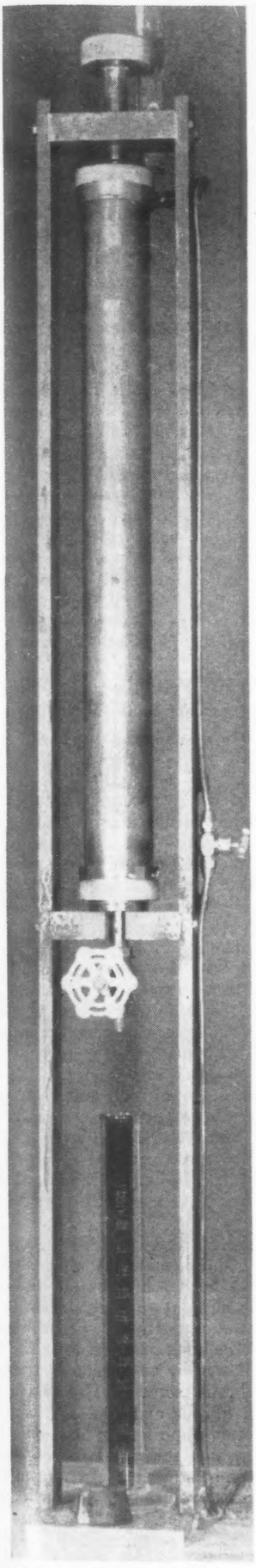


FIG. 4. Photograph of lost circulation test unit.

might be expected from normal filtration behavior. The test was continued for 30 minutes after the initial surge in order to determine the additional water loss that would correspond to an API corrected water loss. For those cases in which all the mud passed through the gravel packs in the surge loss period, the filtration test could not be performed. After subjecting the filter cake to a final strength test of 500 psig at the end of 30 minutes of filtration, the gravel pack and filter cake were removed from the cell and the thickness and character of the deposited filter cake were observed and recorded.

Plugging Tests on Highly Permeable Consolidated Media. Experiments were performed to compare the ability of several commonly used materials to prevent loss of mud into highly permeable consolidated formations. Two fibrous materials, designated A and B, a flaky material, designated C, and leather fiber were employed in a five weight per cent bentonite mud at a concentration of three pounds per barrel. Alundum plugs, one inch in diameter by two inches long and of approximately five darcys permeability, were saturated with water and mounted in a modified Hassler-type cell; approximately 30 cc of mud were then placed above the plug. Nitrogen pressure of 100 psig was applied to the mud to attempt to force it through the sample.

Several experiments were performed using three pounds per barrel of leather fiber in a five weight per cent bentonite mud on 1800-darcy synthetic consolidated samples. These samples were plugs one inch in diameter by two inches in length, and were tested in a modified Hassler-type permeability cell using the technique described above.

Plugging Tests on Fractures. A one inch diameter cylindrical Alundum plug one-half inch long was split lengthwise and the two half-cylinders fitted together in order to simulate a fractured formation. The estimated distance between the newly exposed walls of the two half-cylinders (crack width) was 0.004 in. The effective permeability of the plug to water was about five darcys, based on its circular cross-sectional area. As the water permeability of the unfractured Alundum plug was only about 0.1 darcy, it was assumed that the five-darcy value could be attributed almost entirely to the presence of the crack. A five weight per cent bentonite mud was brought into contact with the plug in a modified Hassler cell, a 100-psig pressure was applied to the mud, and the amount of mud loss before plugging was noted. The fractured plug was then cleaned, and the procedure repeated with the same mud containing three pounds per barrel of leather fiber.

Tests of Permeability of Fibrous Materials. The pliable, tangled nature of leather fiber and its effectiveness in reducing mud loss into porous materials of low permeability suggested that the leather fiber may be effective in forming a very impermeable mat by itself, without the necessity of mud solids being incorporated in the filter cake. In order to demonstrate this property, a conventional wall-builder testing unit was used, and Whatman No. 52 filter paper was employed as the filter system. A suspension of three pounds per barrel of leather fiber in water was used as the test solution.

Bacterial Stability Tests. The bacterial stabilities of leather fiber, sugar cane fibers, and cellophane flake were determined by inoculating a sterile portion of suspensions of each material with manured soil in a mineral medium of ideal composition for bacterial attack on the suspensions. The cultures were then incubated at a favorable temperature (86 F) for bacterial growth. Decomposition was shown by fermentation and its magnitude indicated by the rate

TABLE 1. Static evaluation of lost returns additives in 8 per cent high-yield clay mud on 6-8 mesh gravel.

Additive concentration = 5 lb per barrel.

Additive	Type	Material	Surge loss, cc	Cake thickness, in.	500 psi pressure text
Leather fiber	Fiber	Leather fiber	138	1/4	OK
A	Granular	Hydrocarbon resin	155	1/8	OK
B	Granular	Expanded perlite	156	1/2	OK
C	Granular	Ground douglas fir bark	175	0	OK
D	Granular	Ground douglas fir bark	240	1 1/2	OK
E	Fiber	Chicken feathers	320	1	OK
F	Flake	Flat cellulose	330	1/2	OK
G	Flake	Crushed cellulose	350	1 1/4	OK
H	Fiber	Ground asbestos	452	0	Broke through completely
I	Fiber	Sugar cane fiber	456	1/2	OK
J	Flake	Mica	500	3/4	OK
K	Fiber	Sugar cane fiber	590	1/2	OK
L	Granular	Sawdust	610	1 1/4	—
M	Fiber	Wood pulp	610	0	OK
N	Granular	Ground douglas fir bark	620	1/8	OK
O	Fiber	Shredded newspaper	668	0	Broke through completely
P	Granular	Ground rubber	693	0	Broke through completely
Q	Fiber	Shredded writing paper	750	0	OK
R	Granular	Oat hulls	Did not plug	2	—
S	Granular	Expanded perlite	Did not plug	—	—
T	Granular	Expanded perlite	Did not plug	1/2	—
U	Granular	Cottonseed hulls	Did not plug	1 1/2	—
V	Fiber	Redwood fiber	Did not plug	1	—
W	Granular	Ground douglas fir bark	Did not plug	—	—
X	Granular	Ground douglas fir bark	Did not plug	—	—
Y	Granular	Ground douglas fir bark	Did not plug	1/2	—
Z	Granular	Ground douglas fir bark	Did not plug	—	—

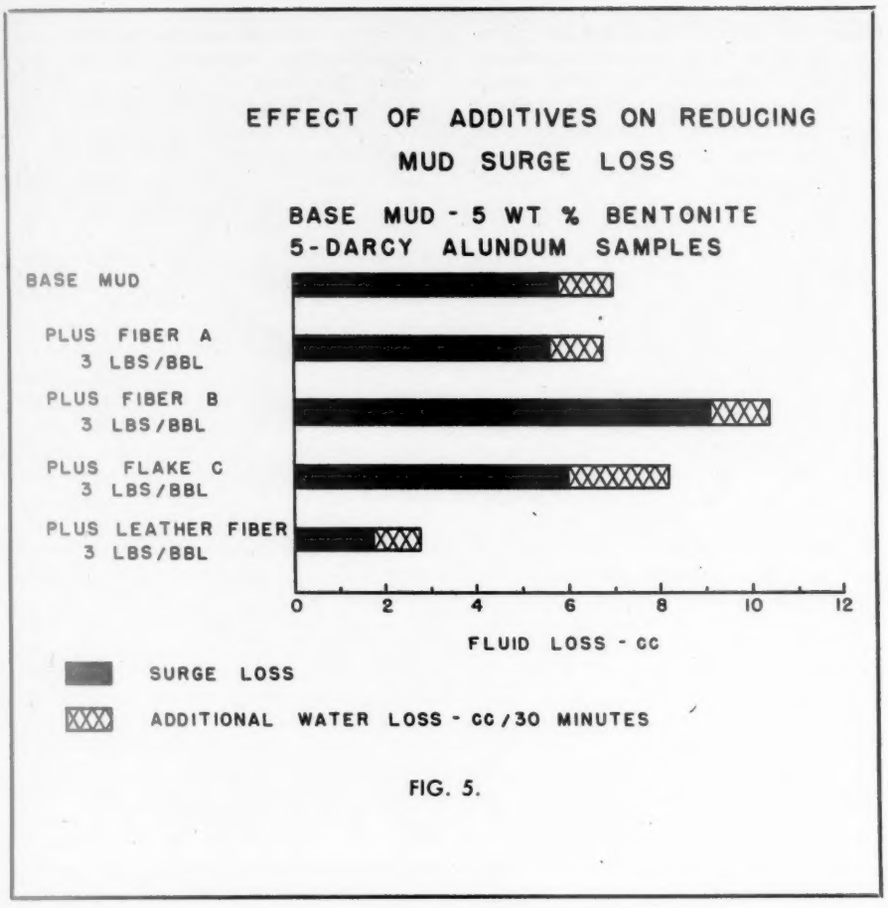


FIG. 5.

at which oxygen was consumed by the bacteria.

Experimental Results

Plugging Tests on Highly Permeable Gravel Packs. Results of the laboratory experiments on 6-8 mesh gravel are presented in Table I. Inspection of this table shows that leather fiber, when added to a mud, was more effective in sealing the pores of the gravel packs than any of the other materials tested. The leather fiber penetrated the packs about one inch, as illustrated in Fig. 1, and effectively plugged the pores after the passage of 138 cc of mud. Only one-quarter inch of filter cake was built up on the gravel pack surface.

In the case of lime-base muds a unique feature of leather fiber was noted. When the leather fibers were mixed into the lime mud they were found capable of stopping the flow of mud through the gravel pack after the passage of some 300 cc of fluid. Although leather is known to be soluble in strong alkali, the ability of the leather fiber to retard lost circulation of lime-base muds was found to persist for several hours. On the other hand, after first heat-aging the leather fiber—lime-base mud mixture for 16 hours at 170 F, it was found that all the mud passed through the gravel bed. The ability of the leather fiber to dissolve in lime-base muds is particularly beneficial in those cases where it is desirable to remove the lost circulation material from the mud system after it is no longer needed to combat lost circulation. For most types of zones the fibers need be present only long enough to permit the formation of a filter cake on the porous formation; after the cake is formed, solution of the leather fibers should be of no consequence. This behavior was tested and confirmed in a field trial to be mentioned later.

Plugging Tests on Highly Permeable Consolidated Media. Results of experiments comparing leather fiber with two other fibrous materials and a flaky material showed that leather fiber was far superior in reducing the loss of mud into a five-darcy Alundum plug. These results are shown in the barograph of Fig. 5. The data presented show that one coarse fibrous material actually caused an increase in mud loss into the porous plug.

Plugging Tests on Fractures. Results of experiments made on a fractured Alundum plug are shown in the following table:

Evaluation of leather fiber in sealing a fractured alundum plug.

Additive	Sample permeability—5 dareys: Surge loss, cc	Total fluid loss, cc
None	5.59	6.95
Leather fiber 3 lbs per barrel	0.90	2.15

The six-fold reduction in surge loss upon addition of leather fiber is considered to be a striking index to the performance of this material. Although these data are meager, they indicate the potential high usefulness of leather fiber in bridging over fractured formations.

Tests of Permeability of Cakes of Fibrous Materials. The experiment using three pounds per barrel of leather fiber in water, carried out in a modified API wall builder, showed that the leather fibers reduced the 30-minute water loss from total loss to 123 cc. The surge loss in this case was 38 cc.

Although these water-loss and surge-loss values are high compared to those of a good drilling mud, these data indicate the very unusual property of a fibrous material to form a cake of low permeability in the absence of mud solids.

Bacterial Stability Tests. It was found that leather fiber did not ferment readily and that in the presence of air or oxygen it decomposed by bacterial action only at a very slow, steady rate. The sugar cane fibers and cellophane flakes were found to ferment rapidly and to support heavy bacterial growth after five days, whereas leather fiber showed only slight growth after the same period. The rate of oxygen consumption by bacteria when sugar cane fibers or cellulose was present was 2½ times as great as when leather fiber was present. It should be noted that these tests were made under the conditions best suited to bacterial growth.

Field Trials With Leather Fiber for Correcting Lost Circulation

A number of applications of leather fiber as a lost circulation additive have been made in a deep West Texas field during drilling through highly fractured zones. Clear water was being used as the drilling fluid. Because of the highly fractured nature of the zones being drilled and the absence of bridging properties in the drilling fluid, lost circulation was a frequent and often severe problem.

It had been the practice to add mixtures of fibrous materials to the drilling water during periods when the fluid loss was too severe to permit continued drilling. This method of combatting lost circulation was only partially satisfactory; also, the fibrous materials used, which were relatively coarse and unpliable, sometimes actually plugged the bit and required removal of pipe from the hole for cleaning the bit. In another case the fibrous material plugged the pumps.

The use of an oil mud with a conventional fibrous material dispersed in water has been relatively successful in restoring circulation in this area. In application, a quantity of special, heavy, viscous oil mud is pumped down the drill pipe, followed by an aqueous suspension of the fibrous material. This mixture of oil mud, fibrous material, and water is then spotted opposite the loss zone. This technique was somewhat more successful in combatting lost circulation than the use of the fibrous material alone in the drilling water.

Leather fiber was first used under the above drilling conditions as an additive to the mixture of oil mud and fibrous material, which had been previously em-

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ployed with limited success, or as a replacement for the coarse fibrous material. It was found that circulation was regained much more effectively when leather fiber was present. In later tests, the leather fiber was added directly to the drilling water when lost circulation was experienced and again beneficial results were obtained.

Leather fiber has been used to restore circulation in 39 field cases. The success of these field tests is exemplified by the following typical cases:

1. In a well drilling in fractured limestone at 7785 ft, complete loss of circulation was experienced. The use of six sacks (50 lb/sk) of leather fiber with the oil-fibrous material mixture that had previously been only partially effective, yielded complete restoration of circulation.

2. Complete loss of circulation occurred while drilling at 8420 ft. Ten sacks of leather fiber and 6 bbl of oil mud spotted opposite the probable location of the loss zone reduced the fluid loss to 15 bph, which permitted drilling to proceed.

3. Complete loss of circulation prevailed at 7968 ft. The addition of 27 sacks of leather fiber to an oil, fibrous material mixture resulted in elimination of fluid loss from the hole.

4. An 80-bph loss of drilling fluid at 7746 ft in one well was completely stopped by five sacks of leather fiber and 5 bbl of oil mud.

5. In one well, several zones were taking drilling water at rates up to 100 bph. As each zone had been encountered, other types of fibrous material had been tried. These materials were completely unsuccessful in reducing the fluid loss. Addition of 10 sacks of leather fiber reduced the fluid loss to about 10 bph, and drilling proceeded.

6. One well was drilled to the top of the fractured limestone section at a depth of 6120 ft, whereupon the drilling water was converted to an emulsion mud. Leather fiber was added to this system and the well was drilled to 9229 ft without appreciable losses of fluid. Emulsion muds employing other types of lost circulation additives experienced complete loss of circulation frequently in other wells in this area that were drilling through similar zones.

7. Leather fiber was added to the drilling water of one well when returns were lost at a depth of 6025 ft. Returns were regained and maintained even when the drilling fluid density was increased to nine pounds per gallon, which normally would have been expected to create a loss of circulation condition in that area.

8. During the drilling of several wells in an area where conventional fibrous materials were normally being used for combating lost circulation difficulties, stuck drill pipe frequently occurred; this was thought to have been caused by the presence of large amounts of the coarser fibrous materials in the hole. In wells in the same area that employed leather fiber, stuck drill pipe was not encountered.

Isotopes to Control Evaluation of Well Acidizing

The successful application of radioactive isotopes to the control and evaluation of oil well acidizing has been announced by Dowell Incorporated, of Tulsa, Oklahoma.

Dowell oil well servicing organization has performed several acidizing treatments using the isotopes on wells in the Kansas City-Lansing and Arbuckle limestones in Western Kansas, and in the dolomitic wells in Oklahoma.

The Iodine-131 emanates gamma rays which penetrate steel tubing, a control which eliminates round-tripping the tube in preparation for a selective acidizing job.

The radioactive acid is pumped down the tubing until it rises to the desired height in the annular space. When the acid in the annular space reaches the level of the Geiger counter, the meter in the pilot truck quickly swings across the scale.

A second pumping unit is then brought into use, increasing the pressure on the radioactive acid in the annulus. This forces the acid into the correct formation.

After completion of the acidizing, the tubing is flushed to wash out the last traces of the radioactive acid. The Geiger counter is then lowered to the bottom of the well and the radioactivity of the formation recorded at each level.

The value of these new materials in the treating of wells was first recognized by Dr. John J. Grebe, of Dowell. The research program has been directed by John R. Niles, of Radioactive Products of Detroit.

From a compilation of the lost time caused by loss of circulation in several wells drilled through the fractured limestone formation, it was found that an average of seven and one-half hours was lost per well when conventional fibrous materials were used, whereas only three and one-half hours per well were lost when leather fiber was used.

In a Gulf Coast field, one trial has been made with leather fiber to restore circulation. In this case, the well lost returns at 5100 ft even though the lime-base mud being used contained another fibrous material. Upon the addition of 20 sacks of leather fiber to the lime-base mud, circulation was restored and the well was drilled to completion with no further lost-returns problems.

Field Trials of Leather Fiber as a Plugging Agent in Water-Injection Wells

The ability of a fibrous material to seal off highly porous zones when only water is used as the drilling fluid would not normally be expected. It was demonstrated, however, by the experimental results obtained with the laboratory wall-builder test of leather fiber in water, described above, that the material should be effective in the plugging of porous sand sections contributing to undesirable by-passing and channeling during water flooding operations.

It has been found that leather fiber is very effective as a plugging agent in water injection wells. One injection well in a water flooding project was taking water at the rate of 451 bbl per day. Injection pressure was 350 psig. Upon addition of only two pounds of leather fiber to the injection water, the input rate decreased to 271 bbl per day. In the opinion of the field staff, the more permeable zones were effectively plugged by the additive.

An even more impressive case was a water injection well that was taking 2100 bbl per day at an injection pressure of 390 psig. Immediately after addition of five lb of leather fiber the injection rate dropped to 48 bbl per day and injection pressure rose to 450 psig. Two days later the injection rate was down to 26 bbl per day and injection pressure was 550 psig. Here again, the field staff considered that the zones causing by-passing were effectively plugged. These data indicate the usefulness of this product in plugging highly permeable zones which otherwise cause channeling and by-passing of the injection waters. An analysis of the reservoir should of course always be made to determine whether it would be desirable to attempt to reduce the injection rate by selective plugging. It should be pointed out that, if necessary, leather fiber can be removed from the surface of the well bore opposite the formation in question by treatment with concentrated alkali.

Acknowledgment

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Effective and Total Porosity in the Redwater D_3 Reservoir, Alberta, Canada†

WALTER ROSE[1], HUGH HAY-ROE[2], R. G. KNABE[3], F. M. TUNNELL[2]

Abstract

A new technique is described for studying under magnification the intergranular and intercrystalline pore structure of polished carbonate rock sections. Data are presented to show that the effective porosity measured on three widely separated samples of the Redwater D_3 zone is considerably less than the total porosity measured on the same samples by the recently described Chalkley method. Such a condition implies that subsequent to the initial development of pore structure in the D_3 zone, deposition has occurred rendering the major portion of the interspaces discontinuous. Whether or not these sealed pore spaces have at any time contained hydrocarbon fluids is not established.

A NUMBER of papers have appeared recently, discussing the pore structure of porous media. Important among these are those of Wyllie and Spangler[4] and Winsauer et al[5], which treat pore shape and pore tortuosity concepts. Both of the cited papers deal almost exclusively with intergranular type sandstones, however, and because of the dearth of published information on the pore structure of intermediate type carbonate rock the work reported in this paper was limited to a treatment of the latter category of porous media. The importance of knowing more about the pore structure of intermediate type carbonate rock is well known, and has, for example, been treated elsewhere recently by one of the present authors[6].

In some respects this paper represents a continuation of the work originally reported by Chin and Rose[7], who were concerned with testing the supposition that the Chalkley method might have utility for distinguishing the component parts making up the pore space of intermediate type carbonate rock. Chin and Rose showed, in fact, that the Chalkley method would give reasonable estimates of vug porosity, but no effort was made to apply the method for the determination of intergranular porosity inasmuch as no technique was then available for viewing and studying the intergranular pore structure under magnification. This paper describes the technique that has been developed for examining magnified surfaces, and the unexpected result that was obtained when an attempt was made to measure the intergranular porosity by the Chalkley method.

By way of completeness, it is worthwhile to recall that the Chalkley method is a laboratory procedure for evaluating porosities and specific surface areas by statistical analysis of Chalkley data. These data are obtained by making a large number of throws of a line of known but arbitrary length on a randomly exposed surface of the rock specimen and counting the so-called Chalkley "hits" and "cuts." The method has been adequately described for geologists and core analysts in previous papers[4,7,8] and without the necessity of further elaboration it can be concluded that the method will give accurate and reproducible estimates of porosity and specific surface area when certain conditions are met. These are: (1) That randomness shall characterize the size, shape, and distribution of the pores throughout the porous medium; (2) that the section viewed (viz. the section on which the Chalkley throws are made) shall be a randomly chosen plane surface through the porous medium; and (3) that a large number of unbiased Chalkley "throws" shall be made. The last two conditions are easily met in practice. The first condition referring to the randomness of the distribution of pore size, shape, and pore orientation, on the other hand, is one over which the experimenter has but little control. As a general statement, however, it may be said that increasing the number and size of samples examined would tend to compensate in part for anisotropy and other heterogenieties in the distribution of pore size, shape, and orientation characteristics.

To explain the course that the work reported in this paper has taken, a review of the early experimental phases will be given. Chin and Rose (loc cit) were interested in showing that the Chalkley method would give information equivalent to that obtained by the planimetering technique described by Waring and Layer,[9] and moreover, that the Chalkley method would be the preferred procedure for obtaining such information, which quantitatively differentiates between the pore type components making up the voidage of intermediate carbonate rock. The present authors in extending the Chin and Rose work were primarily concerned with the problem of viewing the intergranular pore component under magnification so that the Chalkley procedure could be applied. The initial problem was thus thought to be that of satisfactorily impregnating the pores so pore space could be clearly distinguished from solid phase when the section was viewed under magnification.

An effort was made to adapt the procedure of Waldo and Yuster[10] for the impregnation of Redwater D_3 core samples, and a number of difficulties were encountered. For example, 100 per cent impregnation was seldom achieved either in the vug pore regions or in the intergranular pore regions. Two explanations were considered: (a) that insufficient vacuum was applied prior to the impregnation, and (b) that components of the pore structure were discontinuous, thus preventing complete impregnation. Carefully controlled experiments were performed to test the first possibility, and extreme measures were adopted such as providing for prolonged evacuation periods and proper temperatures to insure the entry of the Canada balsam (the impregnating agent) into the pores and such as providing for high pressure (ca. 1000 psig) to promote complete entry. It was found, however, that when impregnation was attempted even under optimum conditions, vug and intergranular pores were not always filled with the Canada balsam impregnating agent. The fact that unimpregnated regions sometimes surrounded impregnated regions, and the fact that unimpregnated regions were sometimes situated closer to the rock specimen surface than were the impregnated regions, suggested that the proper explanation was non-interconnection of certain pores. Proof that there is considerable difference between total porosity and effective porosity in the Redwater D_3 zone (viz. that much of the pore space is non-interconnected) is given elsewhere in this paper. It is worthwhile to record first the limitations that were encountered in the application of the Waldo and Yuster impregnation method and in the thin section preparations; and then to describe the experimental method finally adopted. The following disadvantages of this application of the Waldo and Yuster methods were found:

1. The process is relatively slow and tedious.
2. The dye stained balsam in the thin

†A sponsorship of the Texas Petroleum Research Committee, Contribution 13.

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[3]Graduate student, Department of Geology, University of Texas, (present address, Socony-Vacuum Oil Company of Venezuela, Caracas).

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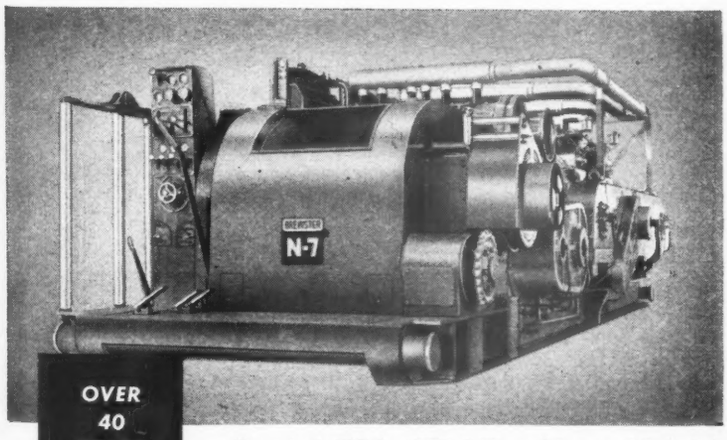

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FIG. 1. Redwater D_3 Reservoir

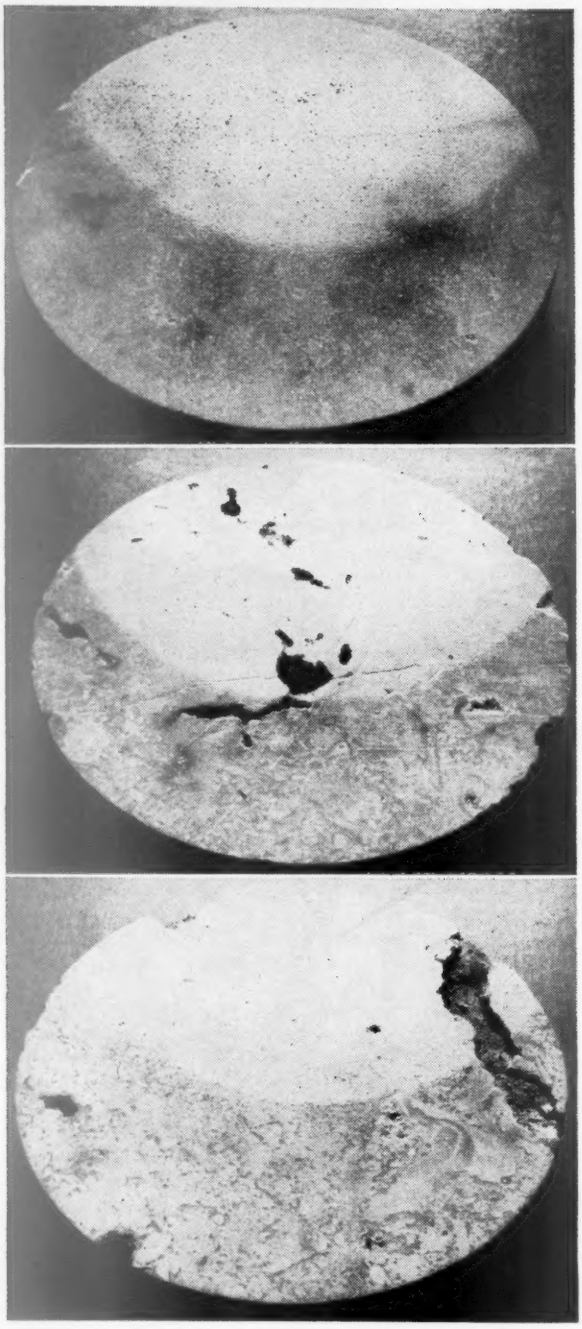

FIG. 1a. Section 1. Depth, 3081.5 ft.

FIG. 1b. Section 2. Depth, 3162.5 ft.

FIG. 1c. Section 3. Depth, 3257.0 ft.

FIG. 2. Magnification of Fig. 1.

(175X)

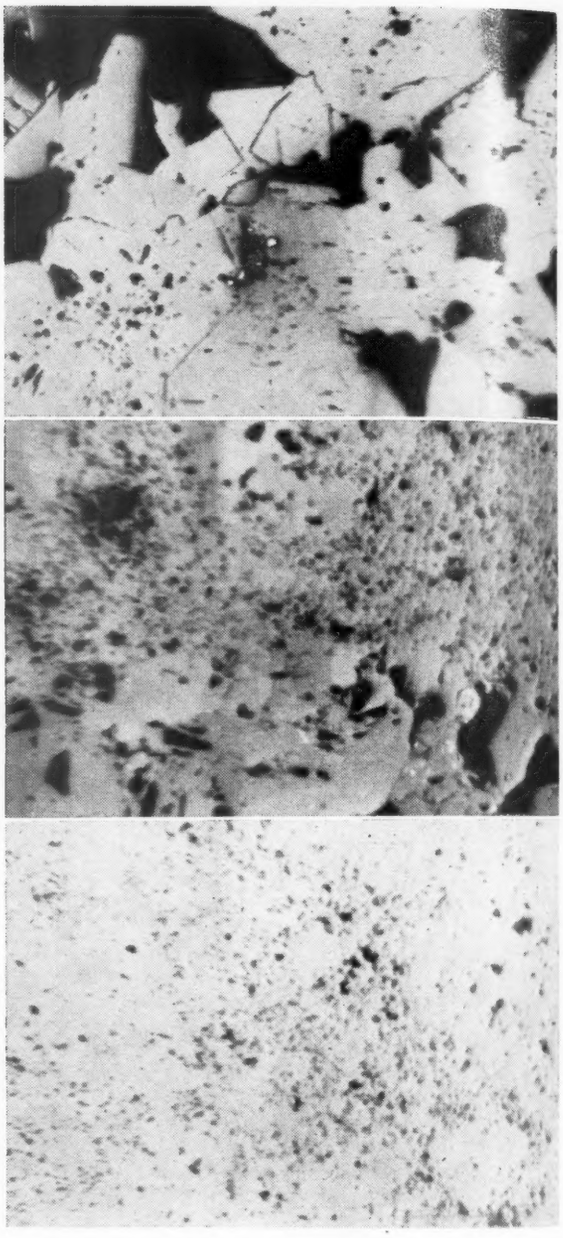

FIG. 2a. Section 1

FIG. 2b. Section 2.

FIG. 2c. Section 3.

sections inevitably smeared when it came in contact with the molten balsam used in cementing the cover glass.

3. At the requisite thinness for microscopic study, the dolomite had almost no strength despite the bonding action of the balsam, and tended to break very easily.

For these reasons, attempts to adapt the Waldo and Yuster method were discontinued, and a new procedure was developed for viewing magnified sections to study pore structure. This procedure is described below.

Experimental Method and Results

Three portions of a complete core from the Imperial Redwater No. 9 (D_3 zone) were selected for detailed study.[11] The characteristics of these portions are given in Table 1, which is taken from data provided by a commercial core laboratory and from a geologist's lithological inspection.

Figs. 1a, 1b, and 1c show the one-inch sections taken from these three portions at the estimated depths of 3081.5 ft, 3162.5 ft, and 3257.0 ft, respectively. The surfaces of these sections have been highly polished according to the procedure described below, and the lighting used for photography was such that one portion of the surface (viz. the fingernail moon portion) shows texture (crystal structure and fossil development), while the other portion, as it reflects light as a mirror, only shows the occurrence of vugs and fractures. Thus Section 1 is seen to have a crystalline texture with evenly distributed small vugs and a few fine cracks. Section 2 has larger but less uniformly distributed vugs and cracks that usually radiate from vugs and that may be open or infilled with crystal growth. Section 3 is

TABLE 1. Core properties.

Depth (feet)	Permeability, md. Maximum	At 90°	Vertical	Porosity (Per cent)	Lithology
1. 3081.4–3082.0	1.9	1.9	0.09	5.6	Vugs and cracks gray, medium hard with oil stains; no fossils; dolomite.
2. 3162.0–3162.9	0.6	0.6	1.7	3.2	Vugs and cracks; light gray and medium hard; fossils; dolomite.
3. 3256.5–3257.2	0.9	0.3	0.1	3.6	Vugs; light gray and medium hard; fossils; dolomite.

similar to Section 2 with regard to the occurrence of fossils and the size of the vugs, but differs in that the vugs are of less frequent occurrence and no cracks are to be found.

The high polish shown on the sections in Fig. 1 was obtained as a substitute procedure to render pore structure visible under magnification. This possibility was discovered quite by accident when the attempts described above to impregnate the pores by the Waldo and Yuster method proved unsuccessful. The polishing technique involves grinding the surfaces to be examined on variable speed lap wheels using the following sequence of materials: Nos. 80, 120, 180, and FFF carborundum powder; levigated alumina powder, and Linde "A" powder. The final polishing with the levigated alumina Linde "A" powders was done on felt covered laps, to give the polished surface a high sheen, free from scratches even when viewed under 200X magnification.

Figs. 2a, 2b, and 2c are 175X magnifications of the top surfaces of the corresponding sections shown in Fig. 1, and it is seen that the high polish was adequate to provide for a clear-cut demarcation between pores and rock matrix. In fact, the definition obtained is as satisfactory as that given by Winsauer et al (loc. cit.) who impregnated sandstone pores with Wood's metal to show structure.[12] The optical system used consisted of a Bausch and Lumb Photomicrographic unit (Model L), including a type CM microscope with vertical illuminator, a reflex back consisting of a clear glass mirror for projecting the image of the polished section upon a ground glass, and a reflector flood lamp. The optical system was used both to obtain the photographs of Fig. 2 and to make the Chalkley porosity measurements according to the procedure outlined by Wyllie and Spangler (loc. cit.) as will be discussed below. First it is of interest to note that Fig. 2 is suggestive [as was Fig. 1] of certain similarities of texture between Sections 2 and 3, and of dissimilarities between these sections and Section 1. The former seem to show eroded pore surfaces, these rounded pore shapes being the same for the microscopic pores as for the visible vugs. On the other hand the pore shapes of Section 1 are distinctly angular and the pore walls are suggestive of crystal structure. It is of interest that none of the larger pores of Fig. 2 show deposition of crystals on the pore walls, suggesting that the term solution channel should be used in preference to the term vug in describing some of the pore structure. True vugs are to be seen in Fig. 1, however.

The Chalkley porosity and specific surface area data given in Table 2 were obtained on the sections illustrated in Figs. 1 and 2 by a technique closely paralleling that recommended by Wyllie and Spangler (loc. cit.). That is, a magnified image of a polished surface of a section was projected on a ground glass and the Chalkley "throws" made thereon. Frequent shifting of the polished section beneath the microscope objective was practiced so that the characteristics of the whole surface of the section would be manifest in the Chalkley data obtained. As is implicit in the discussion given above, the procedure followed differed from the Wyllie and Spangler technique in that reflected light was used to view unimpregnated polished sections, instead of transmitted light to view impregnated thin sections.

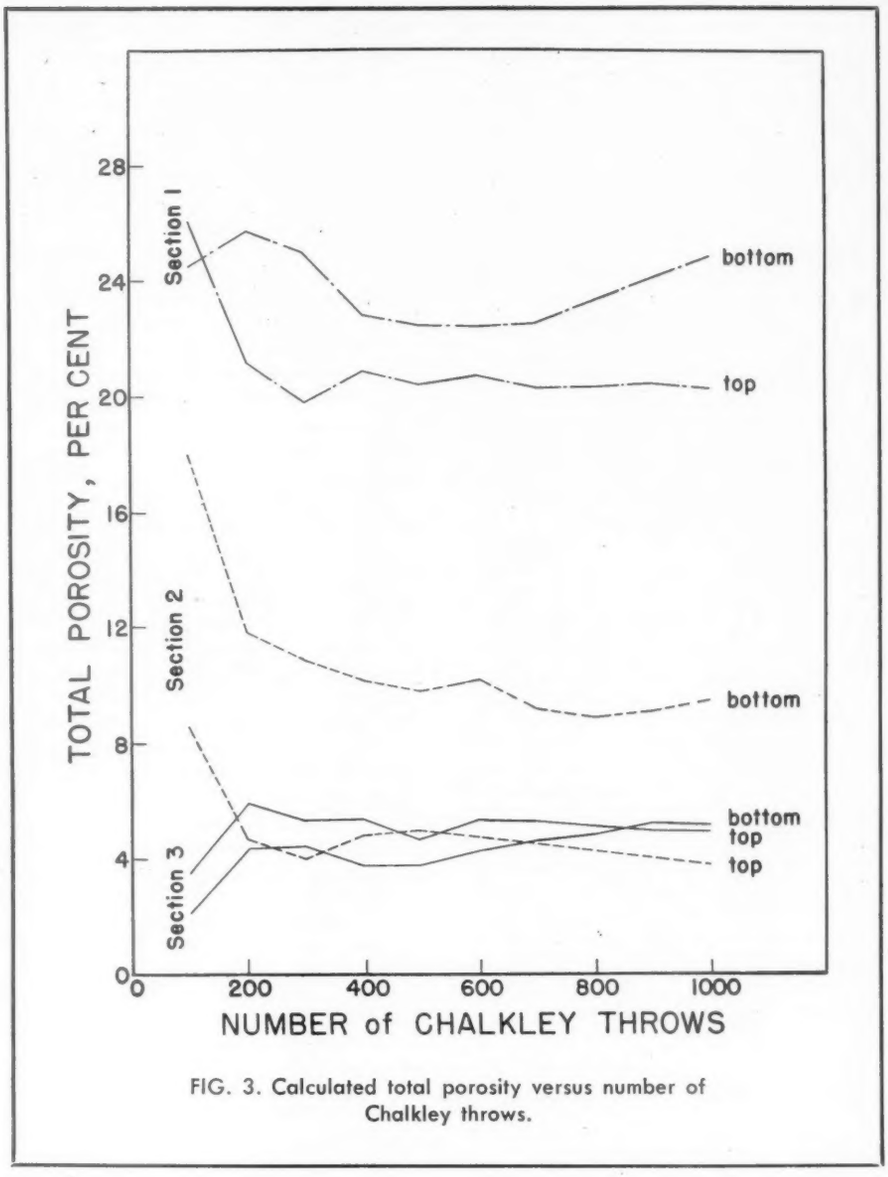

FIG. 3. Calculated total porosity versus number of Chalkley throws.

Fig. 3 is a plot of the porosity as estimated by the Chalkley formula versus the number of Chalkley "throws" used in the calculation. It is seen that after 300 throws the curves become nearly horizontal, which means that the precision and accuracy of the result were not much improved by making the additional throws. The fact that the curves did not become entirely horizontal, however, is important in indicating a limitation in the Chalkley method when quantitative results are required, and will be discussed in due course.

Table 2 compares the total porosity

TABLE 2. Summary of experimental data

Section	Depth (feet)	Chalkley porosity (%)	Total effective porosity (%)	Specific surface area (cm^2/cm^3 grain vol.)
One	—	20.4 (top)	—	—
(c.f. Figs	—	24.9 (bottom)	—	—
1a and 2a)	3081.5	22.6 (avg)	2.3	1.72×10^3
Two	—	3.8 (top)	—	—
(c.f. Figs	—	9.5 (bottom)	—	—
1b and 2b)	3162.5	6.7 (avg)	2.6	5.85×10^2
Three	—	5.0 (top)	—	—
(c.f. Figs	—	5.2 (bottom)	—	—
1c and 2c)	3257.0	5.1 (avg)	2.9	5.80×10^2

of each section as measured by the Chalkley method with the effective porosity as measured by the standard fluid saturation core analysis method. (N. B. Any pore visible under 175X magnification is included as part of the Chalkley total porosity.) The discrepancy between the total and effective porosities so measured is both marked, and, at first glance, alarming. Therefore it is appropriate to consider all possible explanations.

The rather compelling evidence given by previous investigators[4, 7, 8] indicates that Chalkley data do give reliable estimates of porosity under optimum conditions. Although Fig. 3 does not suggest that the data reported in this paper were obtained under optimum conditions (as might also be indicated, for example, by the non-uniform distribution of vugs shown in Figs. 1b and 1c) the discrepancy between the total and effective porosity dose not appear to be explicable by such a consideration. Thus, Fig. 3 does not indicate a probable error in the Chalkley data large enough to explain the discrepancy.

Two reasons can be offered why the effective porosity measured by the fluid saturation method might be low and thus contribute to the observed discrepancy. These are: (1) the low permeability of the core samples increases the difficulty of obtaining complete saturation during the measurement of porosity by the fluid saturation method; and (2) at least one of the cores (i.e., Section 1) originally contained oil, and the extraction process may not have completely emptied the pores of oil before the effective porosity was measured. Both of the possibilities, while in the right direction, would not seem, however, to explain in full the observed discrepancy between the total and effective porosity. This is because enough experience has been gained with the fluid saturation method of effective porosity measurement to know that experimental errors in careful work do not exceed 5 to 10 per cent even under the most adverse conditions. And Table 2 shows that the Chalkley total porosity is greater than the measured effective porosity by between 72 per cent for Section 3 to 872 per cent for Section 1. Moreover, the effective porosities shown in Table 2 for the one-inch thick sections are order of magnitude similar to the effective porosities recorded in Table 1 for the large core from which the sections were cut.

With these considerations in mind, there appears to be no other explanation but that the Redwater D_3 reservoir is characterized by a structure in which much of the porosity is discontinuous. This would explain, and it is in fact what is meant by, the difference between total and effective porosity. Such a possibility does not seem to have been reported in the literature heretofore.

Discussions and Conclusions

The data reported in this paper indicate that a large difference exists between the total and effective porosity of the Redwater D_3 reservoir. Although quantitative data have been presented only on three cores from the 179-ft section, the cores studied were selected randomly from the top, middle, and bottom of the section. Moreover, mention has been made in this paper of efforts to impregnate the pore structure of other cores from the Redwater D_3, which invariably showed incomplete impregnation. Although this observation could be explained in part by faulty impregnation technique, the occurrence of disconnected pores is believed to be the more reasonable explanation in view of the data presented in Table 2.

It is important to record that there is some evidence that, in addition to the observation of discontinuous intergranular pores, there is a similar occurrence of discontinuous vug pores. Such a possibility was not heretofore apparent from the work of Waring and Layer,[9] and Chin and Rose,[7] who usually estimated vug porosity on random sections to be less than the effective porosity measured on the bulk sample by core analysis. Thus, Table 3 compares the vug porosities measured on the top and bottom of each section by the Chalkley method with the effective porosity, and it is seen that half (three) of the sections viewed have vug porosities greater than the respective effective porosities. A possible explanation of why Chin and Rose invariably reported vug to effective porosity ratios less than unity is the circumstance that there was some bias (attested to by W. Rose) in the Chin and Rose work with respect to the selection of samples for study. Thus, Chin and Rose were careful to select only those samples where the vug porosity development was uniform, to assume the relevance and quantitative accuracy of the Chalkley data, whereas the three samples used in the present study were randomly selected, and, with the exception of Section 1, exhibited non-uniform vug development.

It is not possible at this time to speculate on whether or not the disconnected pores of the Redwater D_3 contain hydrocarbon fluids, although this obviously is an important consideration. It may be surmised, however, that the sealed pores at least are fluid-bearing, and probably contain some aqueous phase. This is because it may be presumed that solution action was responsible for the original porosity development, and the subsequent sealing of pores by chemical precipitation would leave residual waters in the sealed pores. This possibility in itself has important consequences from the oil recovery standpoint. For it would appear that any well completion procedure (e.g. acidization or Hydrafrac) that tends to extend paths of pore continuity would, in the case of the Redwater D_3 (and other reservoirs where the total porosity is considerably greater than the effective porosity), tend to augment water-drive recovery possibilities. Moreover, the opening of sealed pores would tend to increase permeability by providing more paths for the flow of oil to the well bore.

TABLE 3.

Section	Chalkley Vug* porosity (%) Top	Bottom	Effective porosity (%)
One	4.7	6.9	2.3
Two	1.6	6.3	2.6
Three	0.7	2.8	2.9

* The term vug in this table designates any pore that could be seen on the polished surface with the naked eye.

The conclusions to be drawn from this paper are the following:

1. The procedure described in this paper for preparation of polished sections for observation of pore structure under magnification is both practical and satisfactory. It is required only that a high sheen polish be obtained and that vertical illumination be available in the optical system. Carbonates such as those found in the Redwater D_3 reservoir are easily polished according to the foregoing requirement.

2. The Redwater D_3 reservoir is characterized by the occurrence of non-interconnected pores, resulting in values of total porosity considerably greater than the effective porosity.

3. The observation of sealed pores in the Redwater D_3 reservoir has an important bearing on the geologic history of the reservoir and on the recovery of oil from the reservoir. These matters deserve further study.

4. The proposal of Chin and Rose[7] that the Chalkley method be used to estimate the vug-to-effective porosity ratio, appears to have only limited validity. That is, the Chalkley method can be expected to work only when the vug development is uniform and when the vug pore structure is continuous.

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11. The Imperial Oil Company kindly made the Redwater No. 9 Core available to The University of Texas for study.
12. Subsequent attempts to obtain high polish on surface of intergranular sandstones has not proved satisfactory, however, presumably because the cementation is not sufficient to prevent the loss of sand grains during the grinding.

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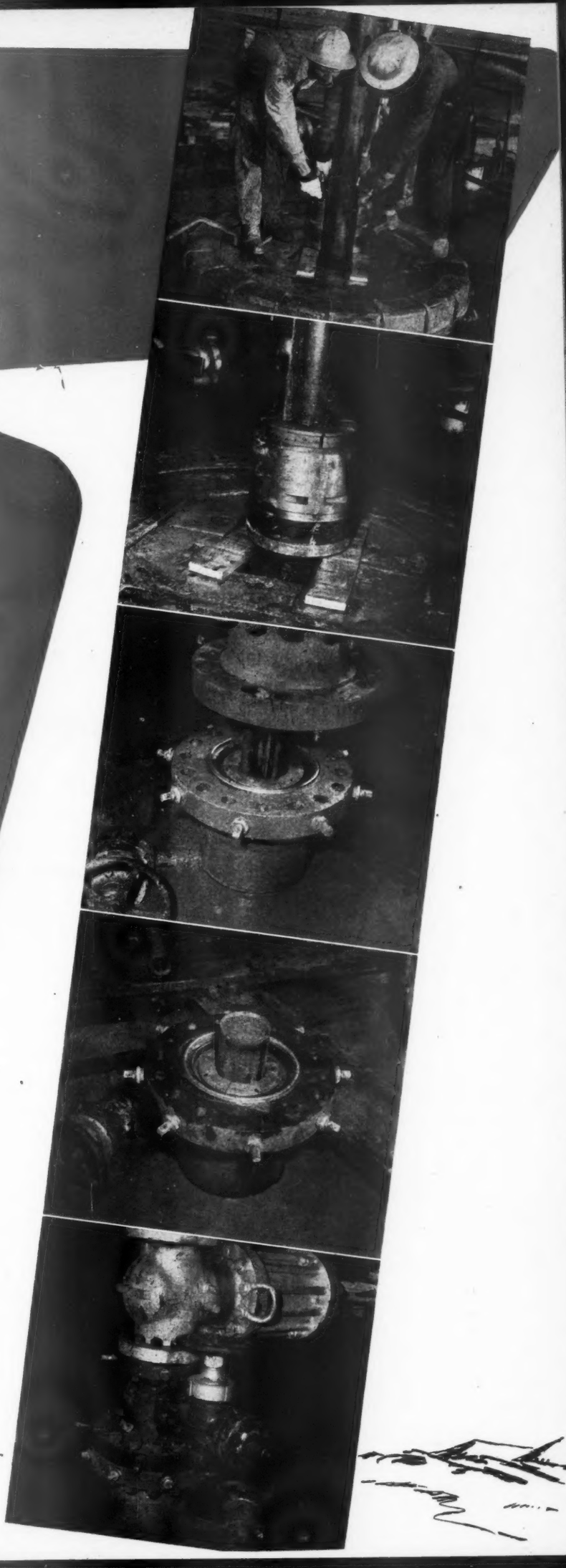

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Loading big truck used to haul heavy machinery at Houston, Texas.

Heavy Portable Drilling Rig for Foreign Operations

R. E. NORTON* and WILLIAM OHLANDT, JR.*

THE Texas Petroleum Company recently purchased a heavy trailer mounted drilling rig for operations in the state of Falcon in Venezuela. This rig is rated for drilling to 8000 ft with 4-in., 14 lb drill pipe and a maximum of 10,000 ft with 3½-in. drill pipe. The rig was designed and built to company specifications and incorporates several unique features. Rig consists of a Wagner-Morehouse T-3-44 drawworks and two National Ideal C-350 mud pumps mounted on three independent lowboy trailers each powered by four Cummins NH-600 diesel engines driving through independent Allison torque converters, and to be used with an Emsco cantilever type single bulge 136-ft derrick. The entire rig is air-controlled from the driller's position and all electric motors and lights are controlled from a central switch panel on the rig floor. Wherever possible all mud, air, water, fuel, and oil lines and electric conduits have been built into the trailers and substructures. The mud manifolding, which was all prefabricated in the States, was designed insofar as possible to move with the units with a minimum of disassembly.

The drawworks unit consists of the double drum drawworks 4-engine transmission with the Cummins engines and the starting air compressor all mounted on a semi-trailer some 47 ft long, 12 ft wide and weighing 84,000 lb. The drawworks is so designed that the trailer remains on the ground and rigidly bolts into the substructure members, thus taking advantage of the weight of the drawworks to hold the substructure in place while raising the mast. With the trailer on the ground, the driller is in his conventional position at the floor height of 8 ft. 6 in. The catshaft is raised above the drawworks to a convenient operating height and has two air-operated catheads. Emergency engine cut-off switches are located at each cathead and at the driller's console. The catshaft may be reversed by a single control, which operates two interlocking air clutches.

The brake flanges are 8½ by 44 in. in diameter and are cooled with a spray cooling system. The inertia brake, a dynamatic eddy-current type, is located in front of the drawworks just inside the rotary drive chain guard. It is half submerged below the derrick floor and is chain-driven from the main drum shaft through an air operated clutch. There is a safety warning device to warn the driller if the dynamatic brake is engaged before the cooling-water has been turned on.

The transmission, which is an integral part of the drawworks, is a 500 ATC unit with two forward speeds and one reverse, additional speed variation being obtained through the torque converters.

The lubrication of the drawworks and transmission is accomplished by an Alemite dual progressive centralized lubrication system. A few strokes of the grease gun, which is situated on the frame just inside the breakout cathead, meters lubricant to 28 different points on the closed circuit. The main shaft and sand reel bearings, dynamatic brake and cathead, must be greased separately.

The drawworks is powered by four Cummins Model NH-600 diesel engines driving through individual Allison TC655 torque converters and Fawick Model 18CB500 clutches into the chain compound. A low pressure cut-off disengages engine clutches if the air pressure falls below 75 psi, thereby preventing damage to the clutches. The compound is oil-tight and the chains are spray-lubricated by oil from an independent pump system. There are no dog clutches since there is no rig-driven mud pump to necessitate division of the power between pump and rotary. The entire compound is in motion while the rig is in operation, although any engine or combination of engines may be disconnected through the individual Fawick clutches.

Each engine has a heavy-duty continuous output rating of 132 hp at 1800 rpm and an intermittent heavy-duty rating of 174 hp. Each engine is equipped with automatic crankcase level controls that draw lubricating oil from a 50 gal reservoir mounted on the trailer gooseneck. In this manner, oil is supplied through a closed system to each engine, maintaining a constant level in the individual crankcases. The 300-gal diesel fuel tank is also mounted on the trailer gooseneck.

Starting air for all 12 engines is supplied by Gardner-Denver Model ADR-100-9 compressor powered by a Caterpillar D-311X diesel engine. Engine, compressor, and air receiver are mounted in back of the No. 4 engine on the drawworks trailer. Operating air for the clutches is supplied by small individual Westinghouse compressors on each Cummins engine.

There are two identical slush pump units with the rig. Each pump trailer complete weighs 86,000 lb, measures some 47 ft long by 11 ft 6 in. wide. Each unit consists of a National Ideal C-350 (7¾ in. by 18 in. pump) powered by

*Equipment engineer, Texas Petroleum Company, Venezuela.

EXCLUSIVE

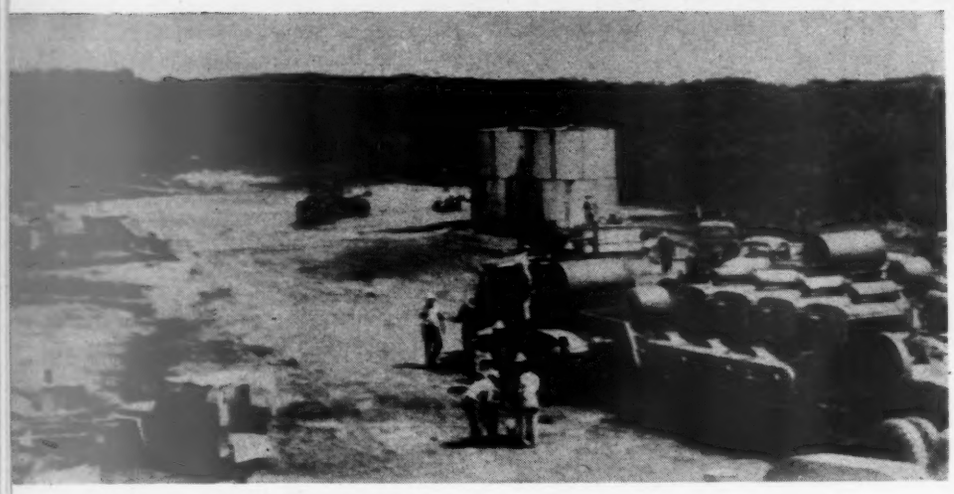
This Mack LMSW-M is one of two used to haul the trailers carrying the drilling rig. The tractor, weighing 34,575 lb, hauled an 86,000-lb trailer on improved roads at a speed of 32 mph.

4 Cummins NH-600 engines, all mounted on a lowboy trailer. Here again the 4-engine unit for each pump is identical to the 4-engine on the drawworks trailer, each engine driving through its own Allison torque converter and Fawick clutch into the 4-engine chain compound. Each pump is mounted directly on the lowboy frame, which is designed to replace the usual steel skids, and with the pump suction brought down to the minimum distance from the ground (46½ in.) when the unit is in working position. Each unit is equipped with a Texas Iron Works pulsation damper and the manifolding is arranged so that the pumps may be worked either in series or parallel. There are two identical sets of air controls for each pump, one mounted on the pump trailer, and a remote control duplicate mounted on the derrick floor in back of the driller. Thus, either pump may be controlled from the derrick floor or at its respective location. Each control unit includes individual engine clutch control, throttle control (one master), engine cut-off (one master), and exhaust cooling water (one master). It should be noted that there is no master pump clutch. Instead, the individual engine clutches are engaged while the engines are idling, and the engines are brought up to speed with the torque converters acting as the flexible link. A fine degree of control of mud volume and pressure is possible through this system. The pumps are chain-driven from the compound through a totally enclosed oil-tight guard.

The subbase is a U-shaped structure of conventional design. It consists of two box sections 48 ft long by 7½ ft wide by 8 ft high for the floor, and 5½ ft high for the step-down. Total weight is 34,000 lb. The supporting beams for the rotary table are then bolted in place, together with the 8 in. tie beams and floor support beams. Built into the off-side step-down section of the subbase are two centrifugal pumps, each driven by a 5 hp electric motor. The dynamatic brake cooling-water pump takes suction from the built-in tank, and the discharge from the brake returns to this tank. Thus the brake cooling-water is independent of the main supply once the tank has been filled. The other centrifugal pump is the washdown pump that takes suction directly from the outside rig supply. Both pumps are controlled from the main electric switch panel.

The Emsco Model 17PEX mast is 136 ft high. Base dimensions are 13 ft by 19 ft, and the water table 4 ft 6 in. by 5 ft 6 in. The load rating is 537,000 lb with a racking capacity of 11,000 ft of 4 in. pipe. The net weight, including the crown block, is 60,500 lb, and provision has been made to transport the mast as a single unit. A fifth wheel to accommodate a Mack tractor unit is mounted on the front face of the water table and a special dolly is provided to support the lower portion of the mast. Thus the mast can be transported as a unit with the above provisions. It can

Some of the power equipment (behind the road grader) in transport.



The power machinery on the site before rigging up.

be taken down into a maximum of five sections in the manner of the conventional cantilever mast, or it can be completely disassembled like a derrick for transportation purposes.

The two steel mud tanks are 8 ft wide by 30 ft long by 5 ft deep, and have a combined total capacity of 425 bbl. Each tank is divided in half by a steel partition with a sliding gate, and corresponding sections of each tank are connected by short 10-in. suction lines with valves. A 3 in. line around the rim of each tank serves both as a structural member and as a manifold to carry the utility line to the mud gun. Two Rhumba shale shakers are mounted over a half of one of the tanks. The 3-hp electric motors driving the shakers are controlled from the central control panel. The valves in the 10 in. mud lines are Mudco butterfly valves, and Patterson-Ballagh molded rubber connections are used on all 10 in. connections to the tanks.

There is a third mud tank that is 22 ft long by 8 ft wide by 8 ft deep, which is used as rig storage.

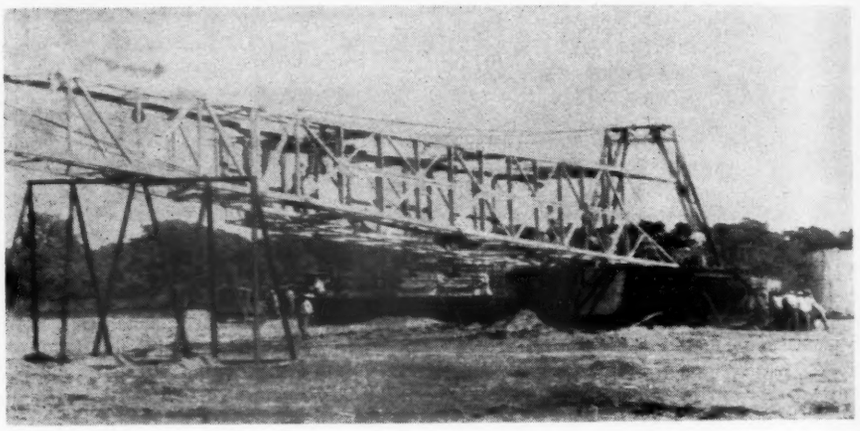
Electricity for the rig is supplied by two Caterpillar D-315, 30 KVA diesel electric generating sets.

To provide the necessary power for moving the heavy trailers, it was necessary to select a heavy tractor type truck to handle the units over dirt road conditions. The units selected were purchased as part of the rig, and for this reason the design was incorporated in the over-all plans. The tractor units selected for this work were the Mack LMSW-M, rated for 150,000 lb GTW in low-bed trailer oil field service. The two tractors are each powered by the NH-600 Cummins engine, making a total of 14 identical engines on the rig. Additional features on this Mack are a 80,000-lb winch powered through a heavy power tower and an extra heavy bogie assembly to take the heavy weight from the trailers. The unit actually is a bob-tailed oil field truck, as it includes 15 ft gin poles. It is not intended as a cargo carrier, but merely to handle the machinery trailers and assist in the necessary rigging up procedure. It is of interest to note that these tractors weigh 34,575 lb each, and with the 86,000 lb trailers handle a GTW of 120,575 lb on improved roads at a speed of 32 miles per hour in overdrive.

The total weight of the equipment assembled in the States for shipment, including the complete rig, mast, manifolding, etc., as well as the equipment items, was 320 tons. The only major item missing was the drill pipe, which was to be furnished in the field.

To make this a complete portable unit, the living camp was designed and transported from the States with the rig. Living camp consisted of 9 aluminum trailers, including five 4-man sleeping trailers, one recreational trailer, one mess hall trailer, one galley trailer, and one kitchen trailer. The units were fabricated to the company's specifications and were shipped complete, even including the kitchen utensils and dishes.

As noted in the beginning of this article, the rig was designed for wildcat drilling in the state of Falcon in Venezuela. The location was some 65 miles



Raising the derrick at the rig site.

Unloading in Venezuela.

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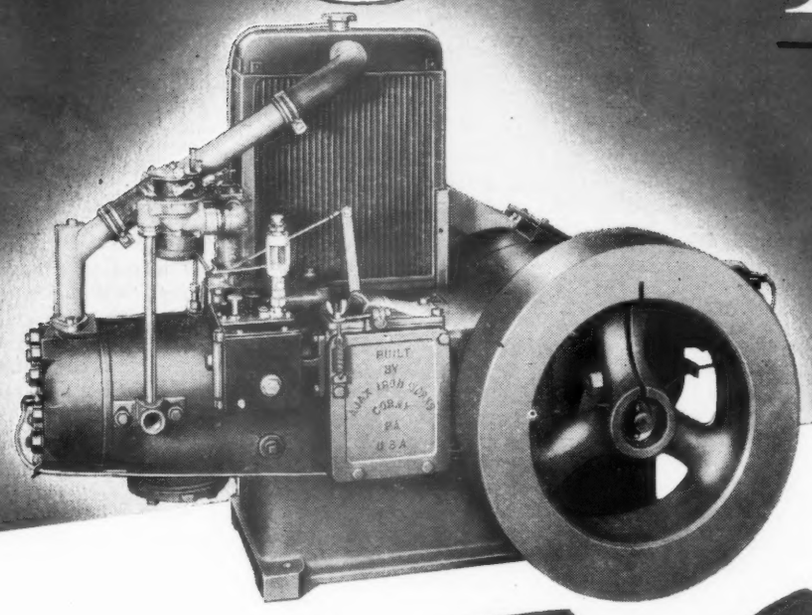

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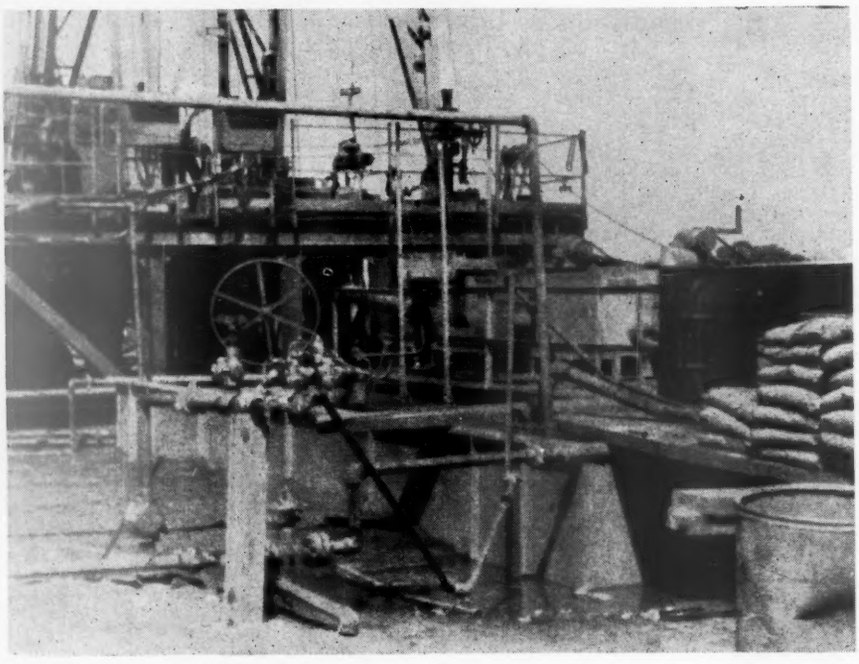
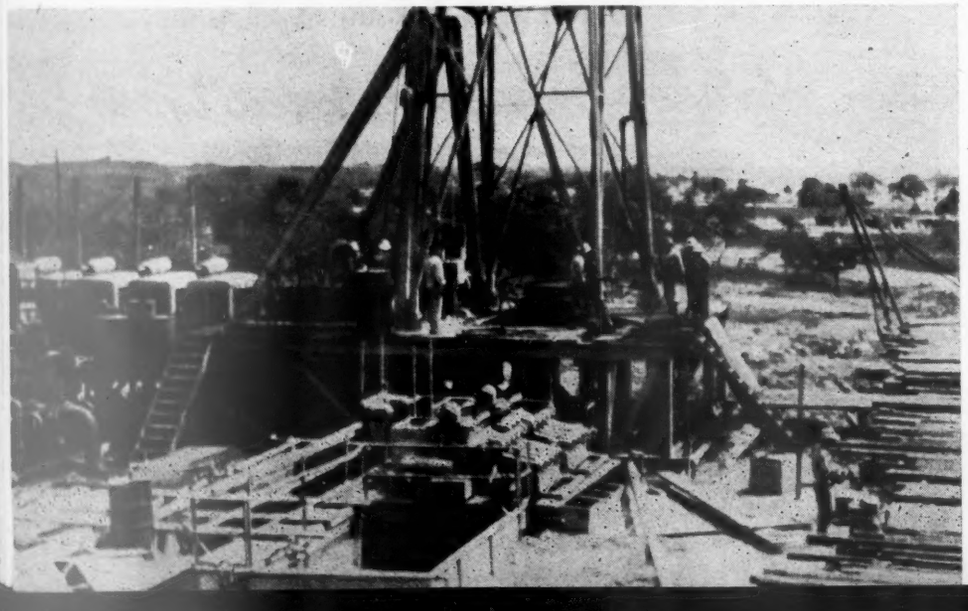
In the final stages of rigging up preparatory to spudding in.



Drilling is now under way.

General view of the layout of equipment at the well.



east of Lake Maracaibo and on the beach. This particular region is barren and very sparsely populated, hence there are no overland roads at all in this area. In order to avoid all the problems necessitated for commercial shipment, such as complete disassembly of the units, crating, reassembly, transportation into an isolated area, etc., the complete project was designed in the states for transportation on a converted LSM that is owned by the Texas Petroleum Company, and the equipment was taken directly to the beach in the immediate vicinity of the location. The LSM made two voyages, one from New York with the living camp, and the other from Houston with the 320 tons of the rig. The unit was designed with the intention of using the LSM with its bow ramp for unloading. For this reason, the limitations of the throat of the ramp constituted a limitation on the maximum over-all dimensions permissible for any single unit. Each unit was designed within these allowable dimensions without disassembly.

In summation of this phase, the complete rig and camp were delivered to the location undamaged in a fully assembled condition. Actual time involved for delivery of the complete rig was 30 days after sailing from the Gulf Coast.

With regard to the actual initial rigging-up time, preparation of the location and the drilling of the water well, some four weeks were required. The initial well was spudded in on April 5, 1951, and drilled to a total depth of 9649 ft on June 8, 1951. The rig was moved to its new location and spudded in the second test on August 5, 1951, the move being delayed because of rainy weather. Except for operating adjustment and minor repairs, the rig was undamaged.

The greatest load was imposed on the rig when drilling at 8214 ft with 4½-in., 16.6-lb drill pipe (the 4 in. pipe designed for use with the rig was not available and the 4½-in. pipe was substituted). The single line pull at this point (11.4 lb mud) was 22,460 lb. The 4½-in. drill pipe was replaced with 3½-in. drill pipe at 9352 ft and this drill pipe used to total depth. The rig was designed for use with six lines, but it was considered advisable to string eight lines at 8214 ft and it has been decided to operate the rig with eight lines. The rig operated to the basic designed specifications of 90 ft per minute off bottom at 8000 ft, with each pump capable of maintaining an annular velocity of 3 ft per second in drilling in 8¾-in hole at 8000 ft. This rig will be kept together as a unit and will continue on wildcat operations in this area for the company. * * *

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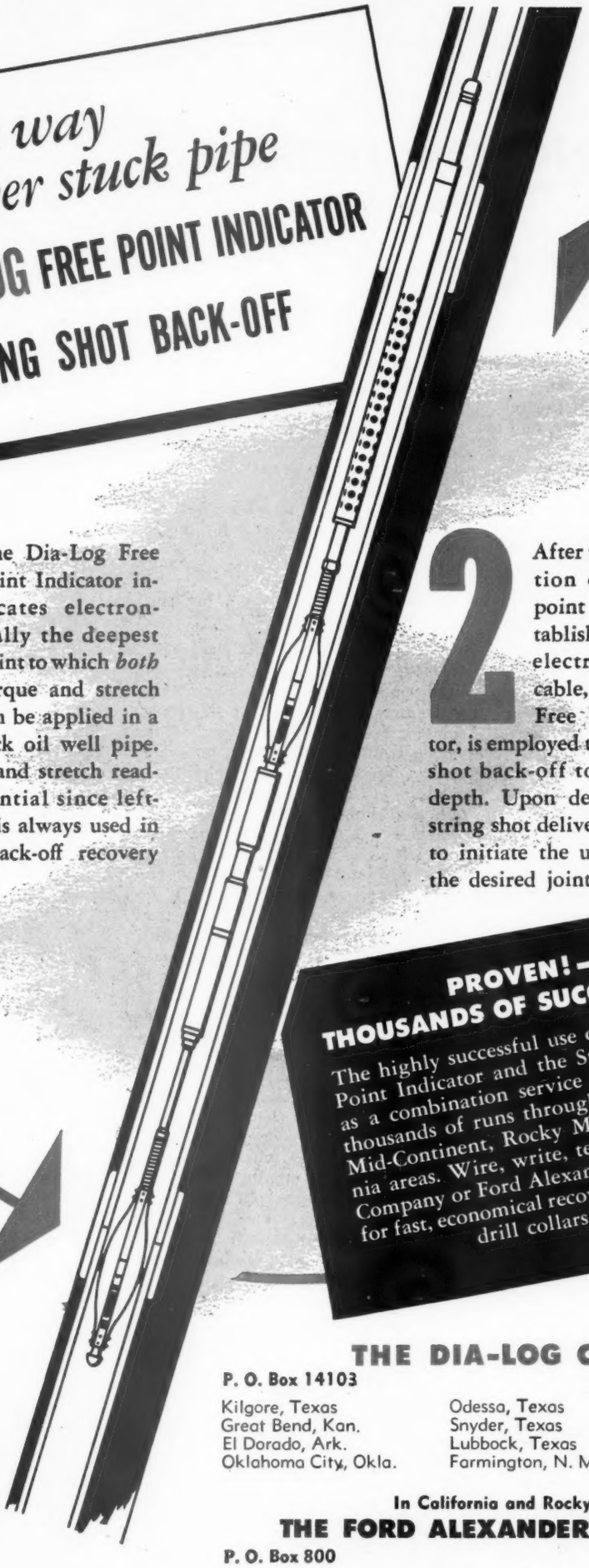

1 The Dia-Log Free Point Indicator indicates electronically the deepest point to which *both* torque and stretch can be applied in a string of stuck oil well pipe. Both torque and stretch readings are essential since left-hand torque is always used in subsequent back-off recovery operations.

2 After the exact location of the stuck point has been established, the same electric conductor cable, used for the Free Point Indicator, is employed to run a string shot back-off to the desired depth. Upon detonation, the string shot delivers a sharp jar to initiate the unscrewing of the desired joint.

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Principles of

GAS ANCHOR DESIGN

NORMAN C. WELLS*

THE need for better gas separation in high fluid level, frothy wells has been recognized by the industry for some time. The problem is of major economic importance in the field of pumping oil wells and has been solved, to date, only to a very limited degree.

Conventional anchors lose their effectiveness when their top-most perforations are covered by froth or liquid. Packer types, though more effective, still require good gas separators above them for most efficient operation, even after determination of proper setting depth.

Using a new principle of gas separation and discharge, an anchor has now been developed based on a sound design theory to function at either a pumped-off or submerged position to make possible the more efficient pumping of gassy, frothy fluids. To understand its operation better, it would be best to review some theory on froth before discussing working principles and to define, for the purpose of this discussion, the difference between froth and foam. Though Webster makes no definite distinction between the two, each seems to apply to a definite and different state of being and should be identified accordingly.

An oil froth, as is illustrated in the pressure gradient curve No. 1, Fig. 1, is assumed to be in dynamic equilibrium. As such it has several properties that remain constant with a given gravity oil and with constant well conditions.

1. The density gradient is constant.
2. Gas moves up through it as bubbles at a saturated condition, i.e., it has the maximum number of bubbles per foot that it can contain.
3. The liquid in it oscillates but its net upward or downward travel is nil.
4. The bubbles have assumed a rhombohedral configuration.[1]

Foam, as contrasted to froth, is in a state of static equilibrium. It consists solely of gas and a liquid film. The difference in configuration is illustrated by Fig. 2 in two dimensions only. Froth consists of bubbles with liquid filling the interstices. As a result of the difference, the specific gravity of froth is considerably higher than that of foam. Also, foam exists under substantially a static condition and is readily broken down by movement or contact with solid objects or by gas in motion. About the lowest density froth found in oil wells would be in the neighborhood of 0.08 psi per foot. Contrasted with this might be a density of 0.005 psi per foot for a foam of high gravity oil. For these reasons, foam is disregarded in considerations of gas anchor design. If it exists in any quiescent point in a gas anchor, it can be treated as gas.

This leaves the following fluids to be considered in an oil well for the purpose of gas anchor design.

1. Gas.
2. Froth.
3. Liquid with entrained gas.
4. Liquid.

For the purpose of this discussion, a typical gassy well, pumping under stabilized conditions (dynamic equilibrium) with fairly high gravity oil will be considered. Fortunately, wells with considerable froth over the pump have many points of similarity under equilibrium conditions. In the usual case, there are only two fluid density gradients from the surface to the pump, that of the gas and that of the froth. In some cases, not commonly found, there can be as many as four gradients as shown in Fig. 1.

With the pump submerged in froth, the fluid above the pump in the annulus contains the maximum possible number of bubbles passing upward through the liquid, as previously stated. If it did not contain the maximum possible number of bubbles escaping through this liquid per unit of time, there would be more forthcoming from the well until it did. And we have assumed that equilibrium conditions already exist. Now, for the sake of argument, let us assume that a gas anchor releases into this state of equilibrium in the annulus a stream of bubbles—not free gas, but bubbles. As these bubbles are assumed to be entering a system already saturated with bubbles, a corresponding number of bubbles coming up from below this point of entry must be excluded from the system and have no place to go but through the pump. What actually takes place is that there is no movement of bubbles from the gas anchor.

Fundamentally, therefore, a submerged conventional gas anchor cannot separate out bubbles and discharge them into a froth and, therefore, it will not function in a submerged condition in froth. The liquid level must be below the top gas discharge aperture so that gas can escape from a liquid-gas interface as free gas and not as bubbles in a froth.

Depressing the fluid level (top of the froth) to the gas anchor so that it can function will result in the same pressure at pump and consequently the same back pressure against the formation and same production. Nothing is gained production-wise by increasing casing pressure.

In designing a gas anchor to operate submerged in froth, the logical procedure is to create a liquid-gas interface within the anchor and to discharge the separated gas into the annulus as free gas without any liquid accompanying it. This is accomplished by the application of a new principle in the design that will cause gas to be separated out in the gas anchor at an artificially created liquid-gas interface while the tool itself is submerged. Further, to enhance the travel of the gas up the annulus through froth, it is discharged at a pulsating rate in harmony with the reciprocation of the pump, the only moving part consisting of one, or more, ball check valves.

Any type of separating design may be used in conjunction with this principle. For this reason, Fig. 3 shows only the top part of a gas anchor diagrammatically. The lower part, not shown, would incorporate some means of coalescing small gas bubbles and keeping the resultant large bubbles substantially away from the pump inlet. Rising in the tool, these bubbles would break out from the gas-liquid interface into a space filled with free gas.

Referring to Fig. 3, the important features of the design are the pressure required to open valves C, the distance from C to D, and the density of the fluid in the annulus between the tool and the casing. The height of fluid above A and C is unimportant. Assuming a fluid density of 0.10 psi per foot in the annulus and 1000 ft of froth above point A and zero psi above the froth, the pressure at A in the annulus would be 100.00 psi. If the gas-liquid interface in the tool is 24 in. below A, or at B, the pressure at B both outside and inside the tool will be 100.20 psi. Neglecting the density of the gas in the tool, which would be approximately 0.003 psi per foot, the pressure under the valves at C (A) would than be 100.20 psi. Then, if the valves are designed to open with a differential pressure of 0.16 psi, they would be open and venting with a net venting pressure of 0.04 psi. The greater the density of fluid in the annulus or the greater the distance A to B the greater will be the net venting pressure.

When venting has reduced the gas pocket in the top of the tool to the extent that the gas-liquid interface is 19 in. below the valves, the valves will close. Thus, the interface, necessary to gas separation and its subsequent disposal up the annulus as free gas, is always maintained by the proper design of the valves. Also, the interface is maintained above the pump inlet D so that none of this free gas will be drawn into the pump. This is accomplished by properly spacing D below C for the range of fluid densities concerned.

*Consulting Engineer, Long Beach, California.

[1]Jones, Park J. "Some Froth Mechanics with Application to Pumping Wells." Los Angeles A.P.I. Production Committee, May 2, 1939.

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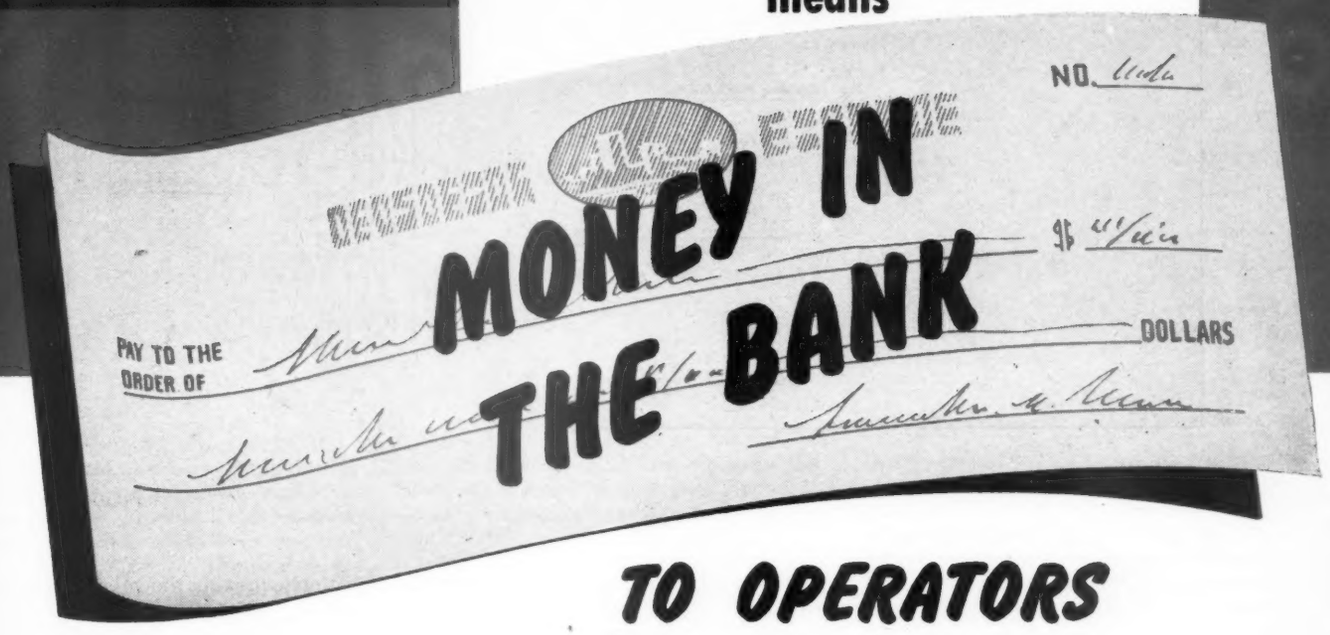

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FIG. 1

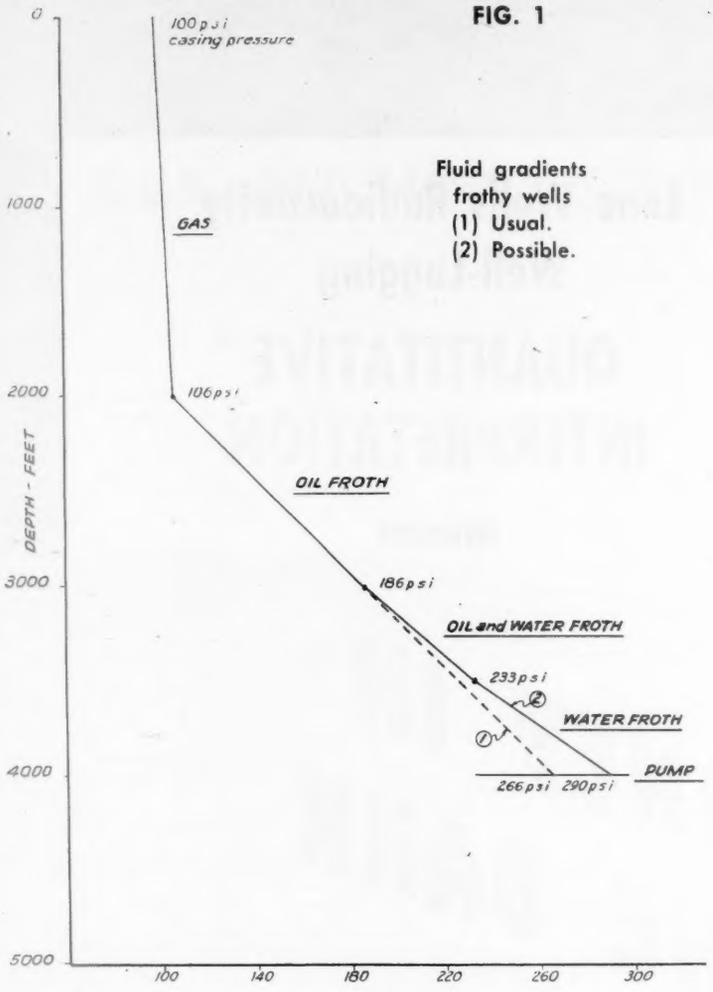

FIG. 2

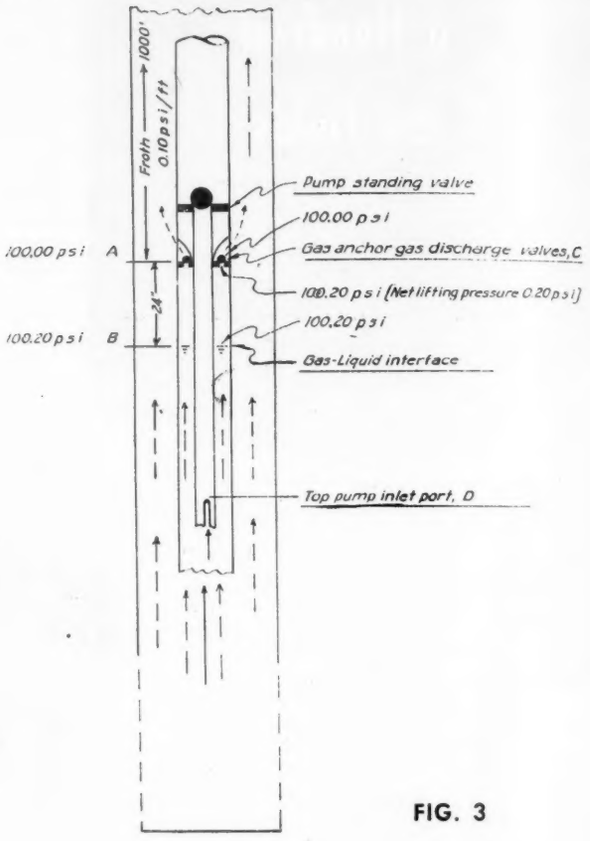

FIG. 3

The distance from C to D and the pressure required to open the valves are so related to each other as to maintain a liquid-gas interface below C and above D at all times with the tool submerged in a fluid of density ranging from 0.06 to 0.46 psi per foot. This range should cover fluids from the lightest froth to the heaviest liquid normally found in an oil well. Some allowance is made in the distance C to D for pressure reduction during the suction stroke of the pump. The pump action causes a rising and falling of the gas-liquid interface, which will result in a pulsating discharge of gas.

Two things should be clarified in considering the working principle of this design. First, that it takes very little gas to gas-lock a pump and reduce its efficiency to a very low figure. Consequently, a small gain in keeping gas out of the pump may have a considerable effect on the production. No large amounts of gas pass through the gas anchor. The maximum quantity of fluid passing through the tool can only equal the pump displacement plus gas vented. Venting the gas as "slugs" of free gas, without any liquid content, into the froth in the annulus will successfully dispose of this gas. Second, any foam that might tend to form above the gas-liquid interface would be very unstable. It would be broken down into gas before escaping from the vent valves. In the meantime, if it does form at all, its density would be extremely low. To all intents and purposes it may be considered to be a gas.

Thus, in a submerged condition, this gas anchor principle will successfully surmount the problem of gas that is otherwise "locked" in the fluid and cannot escape except by passing through the pump.

In the first installation of a gas anchor that incorporates this principle, close control of well conditions was exercised in order to have identical conditions before and after the anchor was installed. Prior to the installation, the well was gas-locking so badly that at times it would pump nothing for 24 hours. The production varied between this and 146 bbl per day of badly emulsified oil and the casing gas chart was extremely erratic. Since the installation, the well produces from 184 to 226 bbl per day regularly, the oil is not badly emulsified and the casing gas chart is smoothed out. The conditions of the test were such that they leave no doubt on what created the change in operational results. At this writing, the well has been producing in this way uninterruptedly for six months.

This aid to pumping frothy wells has been extended over a wide range of conditions and in fields throughout the country, proving the validity of the principles incorporated in the design. In this case, a sound development of principles, even though it led through some relatively new channels of thought, resulted in a design that, when applied to an existing tool, gave the desired result. It is not the intention of the author to philosophize in this paper. It might not be out of place, however, at this point, to mention the fundamental requirements to the reduction of theory to practice as applied to this and similar types of development. Apparently, in this case, the theory was sound and its application in design was practical, thus fulfilling two essential ingredients of success in development engineering, and, incidentally, the necessary ingredients for the strongest type of patent protection for the designer. Experience, of course, is essential in the reduction of theories to practical design. Lack of it will lead to enough trouble to discourage the whole effort. The third and most important ingredient is a forthright management.[2] Without vision and courage from this source, any such development might end up on the shelf, instead of being usefully applied in oil wells, and its benefits completely lost to the industry.

[2]In this case, the Agate Corporation.

* * *

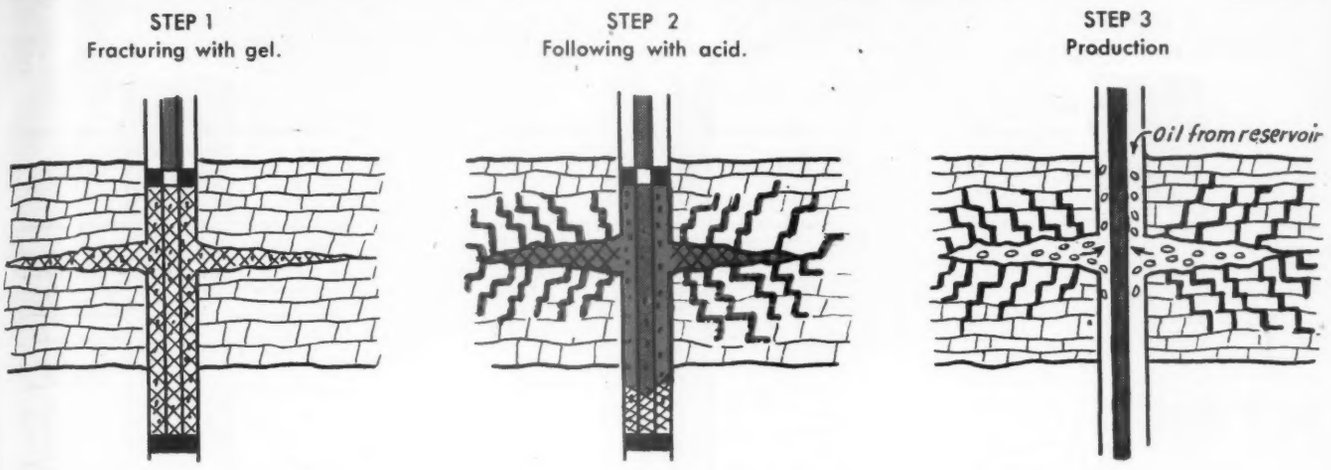

FIG. 1. Hydraulic fracturing and acidizing in limestone formations.

Hydrafrac Methods for Limestone and Dolomite Wells

C. E. CLASON*

THE creation of new permeability by the Hydrafac* process in various sandstone formations has produced thousands of barrels of oil that would otherwise have remained underground. The new theory of hydraulic fracturing with a viscous gel fluid that reverts to a consistency that allows back flow toward the well bore has become an established fact that is accepted and widely used by oil producers.

The treatment of sandstone wells involved no chemical action on the formation. Limestone and dolomite formations have been treated by chemical action of acid for many years. An analysis of the chemical and physical characteristics of both methods indicated that a combination should be a distinct advantage for better results in wells of this type.

The pressures encountered by use of Hydrafrac methods require proper well fittings and cementing operations are now planned to facilitate this new practice. Acidizing has usually been accomplished with less attention being paid to these details because the water-like viscosity allowed injection into the formation with far less difficulty. When a well did allow overburden pressures with perhaps a resulting fracture, the new opening was bound to be of minimum size or height because of the low viscosity. Enlargement would then depend upon flow and injection of greater quantities of acid.

For new low permeability wells, it is now known that an initial fracture made by a viscous gel material allows easier entrance of following regular acid and results in larger flow channels covering a greater drainage area. This is actually an improvement over the old practice of a squib shot previous to an acid

Acidfrac jobs.

*=Pounds of sand
NE=Non-emulsifying acid

County	Formation	Gallons Acidfrac Gel	Gal. acid	Production Before Oil	Before Water	After Oil	After Water
Kansas							
Barton	Arbuckle (old well)	750—*400 lb	1000	4½	3½	8	13
Ellis	Arbuckle (new well ab'd)	750—*600 lb	1000	0	0	0	216
Barton	Arbuckle (old well)	1000—*800 lb	1000	20	Trace	20	Trace
Gove	Miss. (new well ab'd)			6.4	10%	6.4	10%
Oklahoma							
Carter	Miss. (old well)	1000	5000	80		95	
Logan	Avant (new well)	500	1500	4		80	
Seminole	Hunton (new well)	1000	2500	0		96	
Carter	Hunton (new well)	1000	9000	1		24	
Central Texas							
Montague	Strawn (new well)	1000—*400 lb	2000 NE	10	10	10	10
Coke	Strawn (new well)	1000	5000 NE	Show		160	62 Flowing
Nolan	Strawn (new well ab'd)	1000	3000 NE	2	1	2	1 Previous treatment of 750—2000 gal
Michigan							
Midland	Dundee (old well)	3000	3000 NE	5	2	27	0
Missaukee	Richfield (old well)	3000	3000 NE	30	5	43	0
Oceana	Dundee (new well ab'd)	500	2500	½		½	
West Texas							
Upton	San Andres (old well)	1000	3000	17		80	

†Chemical services coordinator, Halliburton Oil Well Cementing Company.
*Reg. U. S. Pat. Office.

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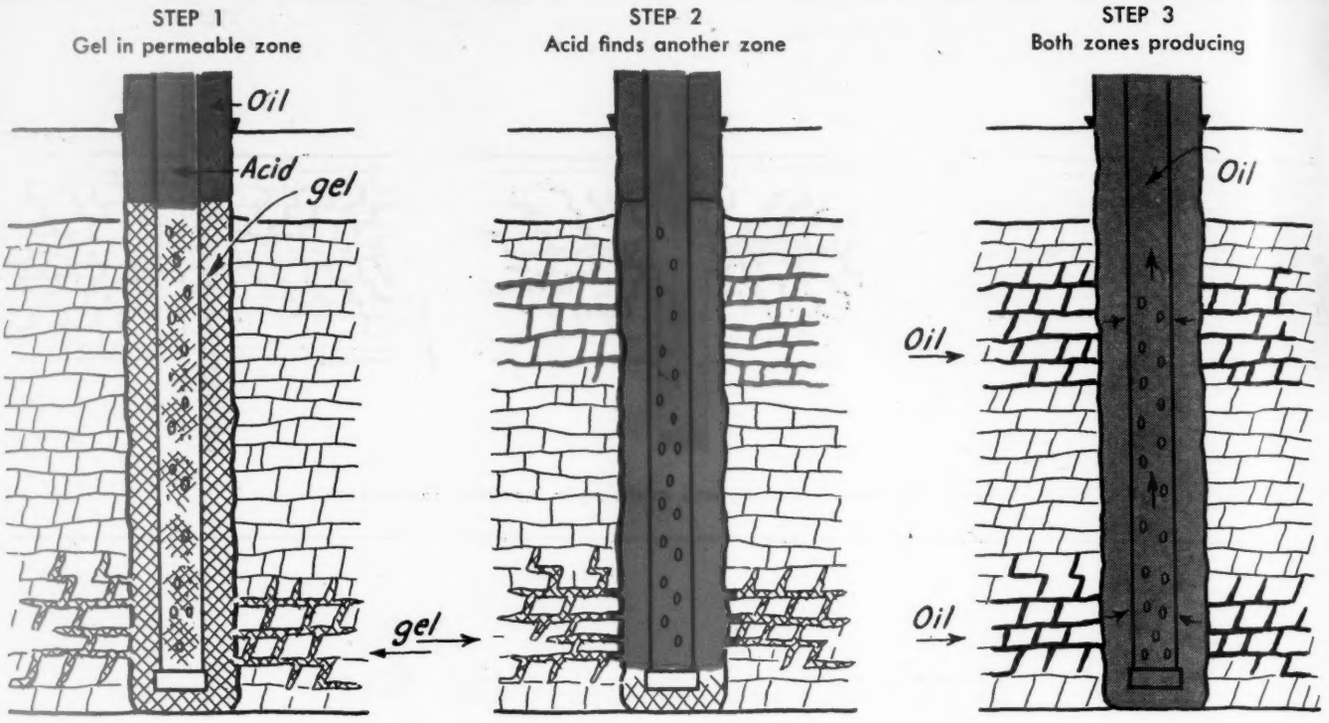

FIG. 2. Retreatment showing temporary plugging of old permeability with gel, allowing following acid to enter next best permeable zone.

job to provide channels for acid entrance. (See Fig. 1.)

A variation has been practiced several times where a known lack of permeability existed, of using a small volume of regular acid ahead of the gel. With fast pumping it was considered possible to cause a small fracture or at least an entrance to a zone of permeability, making it easier for the following gel to create a larger fracture.

Some wells treated with regular acid under high pressures throughout the job and with small increases in production could still have a chance for greater results by using a gel and acid.

Another possibility for improved practice was in the retreatment of wells. Many old wells have one or more zones of great permeability from previous treatments. Attempts to increase production failed because the acid followed the line of least resistance into permeable zones that were already producing as much as the formation pressure provided. Segregation by packers to direct acid into other parts of the well bore was not always successful in open hole and at times through pipe perforations.

A viscous gel has a viscosity of from 4000 to 5000 centipoises as compared to regular acid at around 1.25 centipoises. Theoretically, the resistance to flow in small channels is proportional to this difference in viscosity. Actually the apparent viscosity of a thick fluid decreases with pressure but there is still an active difference that will be in the ratio of 400-500 to 1.

With the above in mind, it can be seen that when a permeable zone is packed with a high viscosity gel it will present a great resistance to flow for regular acid that follows immediately after, and that will be deflected to other parts of the well bore.

This use for retreatments has been quite extensive and has given a wide range of production increases in old wells. Fig. 2 serves to illustrate the mechanism of this type of treatment.

Trouble has been experienced in the past by communication channels breaking through between sets of perforations, with regular acidizing. It has been proved in many cases that gel injection ahead of the regular acid plugged these channels so that injection occurred in the desired place.

Materials and Uses

There are many true well-known limestone or dolomite producing formations that are highly soluble in acid. For these an Acidfrac gel, which is a thickened acid, is used. Reaction with the formation reduces this to a thin spent solution in 3 to 4 hours. There is no thick reaction product or heavy sediment to cause plugging.

This Acidfrac gel is prepared before hauling to well and is stable until reacted. It may be seen and judged for consistency.

Some formations such as Conglom-

Hydrafrac-acid combination jobs

*=Pounds of sand
NE=Non-emulsifying acid

County	Formation	Gal. Gel	Gal. acid	Production Before Oil	Production Before Water	Production After Oil	Production After Water
		Kansas					
Ellis	Arbuckle (old well)	750—*500 lb	500	3½	½	60	100
Barton	Arbuckle (new well ab'd)	1500— 800 lb	1000	0	0	0	200
Ellis	Arbuckle (old well)	750— 500 lb	1000	5	5	60	10
Pratt	Viola (new well)	1500— 800 lb	1000	2	0	336	0
Barton	Arbuckle (old well)	750— 600 lb	2000	10	0	34	10
		Oklahoma					
Oklahoma	Hunton (new well)	1500	4000	0	0		Water
Oklahoma	Hunton (new well)	1500	2000	0	0	70	0
Murray	Hunton (new well)	750	2000	0	0	90	0
Carter	Miss. (new well)	750	4000	4	0	70	0
Carter	Deese (new well)	750	6000	40	0	190	0
Carter	Miss. (new well)	1500	5000	24	0	110	0
Stephens	Hunton (new well)	1500	5000	20	0	100	0
Garvin	Hunton (old well)	1500	3000	0	0	25	0
Stephens	Comanche Limestone (new well ab'd)	1500	2000	0	0	0	0
Garvin	Bromide (new well)	1500	4000	0		0	
		Central Texas					
Tom Green	Canyon Sand (old well)	750	1000NE	0		20	
Eastland	Marble Falls (new well ab'd)	1500	4000NE	2		2	
		Michigan					
Missaukee	Richfield (old well)	1500	3000NE	6		42	

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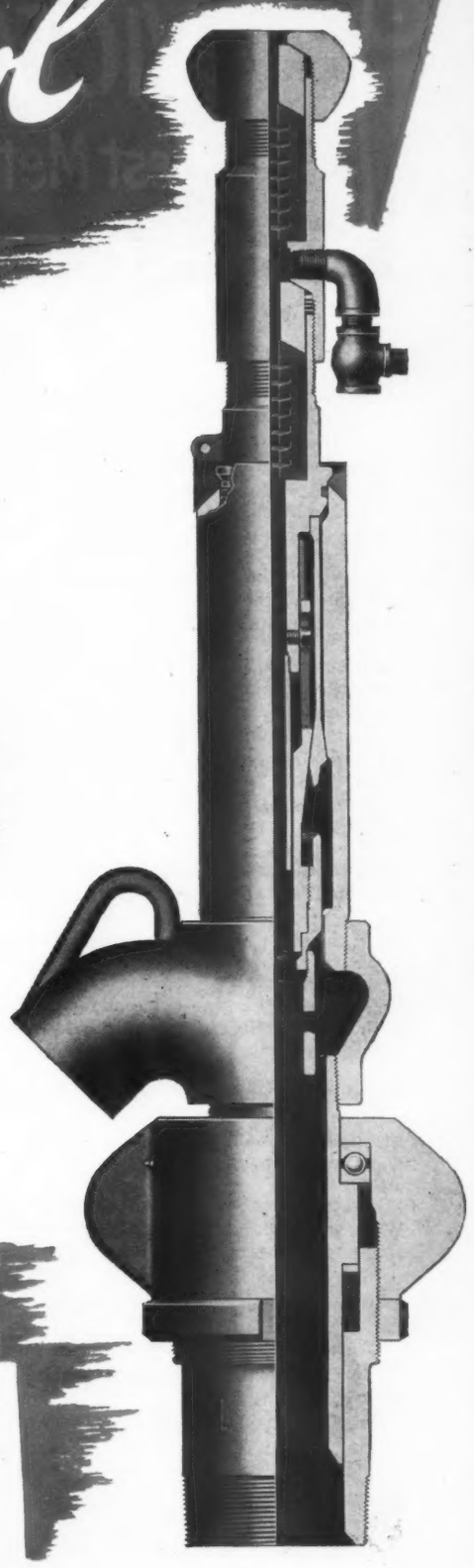

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2. See that AUTOMATIC LOCK? It snaps into position as the tools are lowered, AND NO MOUNT OF PRESSURE CAN BLOW IT OUT. Yet when struck by the rope socket it releases the king unit INSTANTLY. Eliminates need for flagging the line—speeds your operations.

3. With this GOOSENECK CONNECTION, you can attach the regular rotary hose and keep circulation to prevent pipe sticking. Takes any pressure you need for control, and doesn't ke back the flow!

4. This lubricated ball-bearing SWIVEL permits full rotation of the drilling string to further vent freezing the pipe. It rotates with the table while the Gooseneck Connection above remains tionary—and circulation is continued for proper well control.

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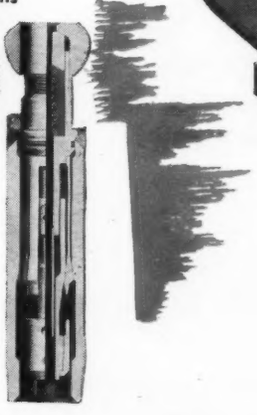

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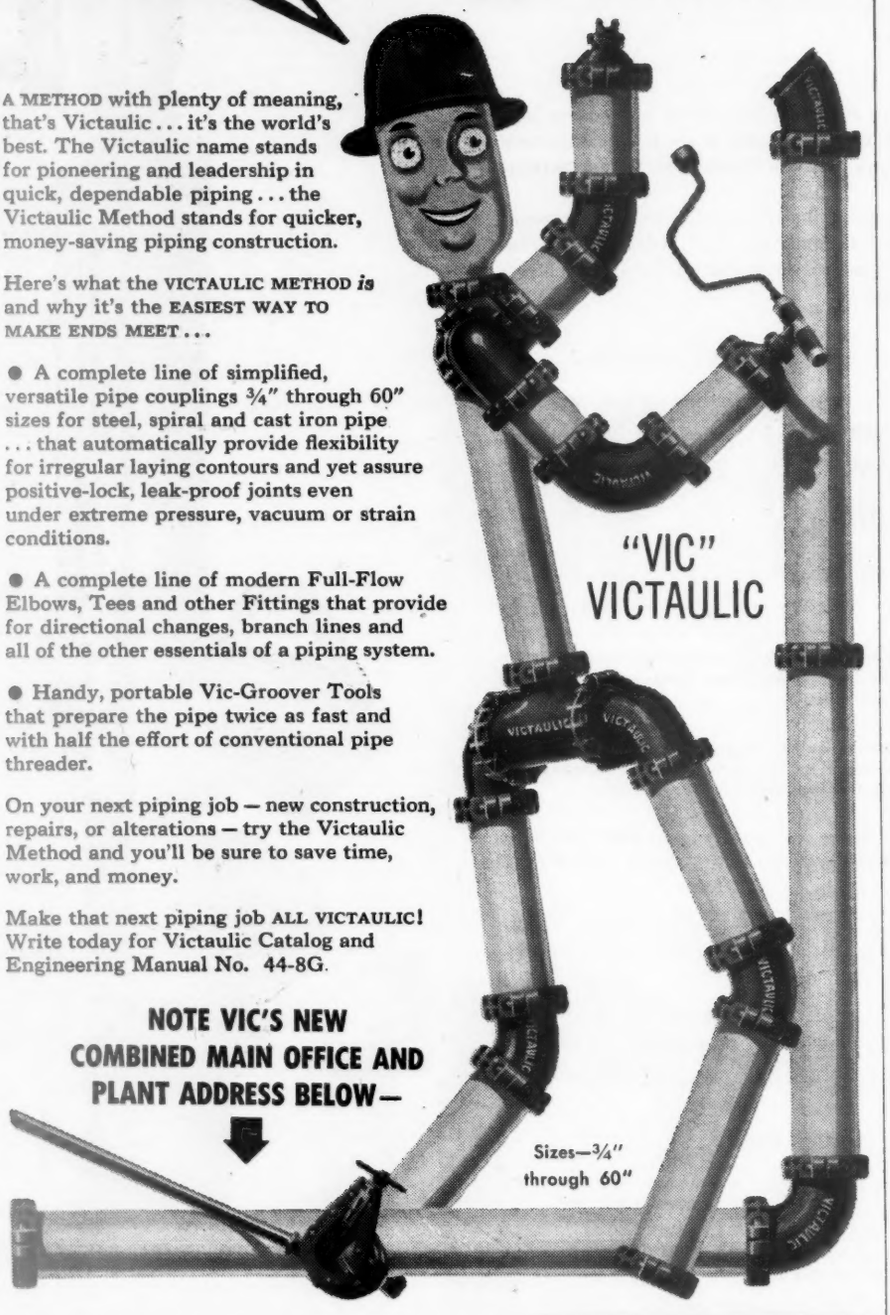

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erates and also the Mississippi limestone can vary in acid solubility. When this solubility is below 40 per cent, the regular hydrocarbon gel fluid common to the basic Hydrafrac method is used in combination with regular acid in the same manner. Fracturing occurs in the same way, the following acid not only aids in breaking down the high viscosity but reacts with the formation.

Sand as a propping agent has been used with either gel. It can be said that a fracture can close up with pressure reduction and before the thickened acid has a chance to react. Thin acid following either gel may induce a pressure reduction that could allow crevice closure. This is an important factor that should be considered.

The acid following either gel is still subject to the same requirements to aid in efficiency and give insurance of a better job. It contains non-emulsifying agents, when found desirable. Formations high in gypsum content have had the acid treated to cut down the insoluble residue and aid in clearing out flow channels when the well is unloaded.

Results From Typical Jobs

The tables show a number of wells from which results have been reported. They were picked at random and give an unbiased cross-sectional view of types of wells and include both methods of treatment. It may be seen that numerous jobs have been last-resort attempts on new wells that occasionally paid off, while others had to be abandoned.

All work on old wells has been either where ordinary acid has failed to increase production or else were old producers with one or more acid treatments in the distant past. Some of this work undoubtedly proved the point of acid deflection and opening up of additional permeability from available oil-bearing strata. * * *

Battelle Is Chosen For Drilling Research

Drilling Research, Inc., a non-profit corporation whose members represent more than half of the world's oil-well drilling capacity, has just initiated at Battelle Institute, Columbus, Ohio, a study of drilling methods.

"It is vital that the cost of drilling an oil well be reduced," said Dr. J. V. Pennington of Houston, Texas, technical director of Drilling Research, Inc., "or vast reserves of marginal production potential cannot be drilled and higher prices for all petroleum products will be inevitable.

"We have asked Battelle to disregard all known drilling techniques and to delve into the realm of the unconventional and 'the impossible'. We are also setting up a basic long-term research plan to insure a healthy progress in years to come."

R. A. Stoner, on loan to Drilling Research, Inc., from California Research Corporation, will be resident coordinator on the study. He will work with W. H. Browne, H. M. Banta, and others.

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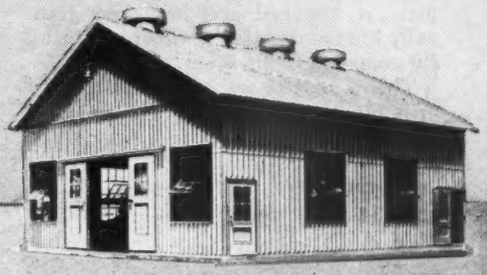

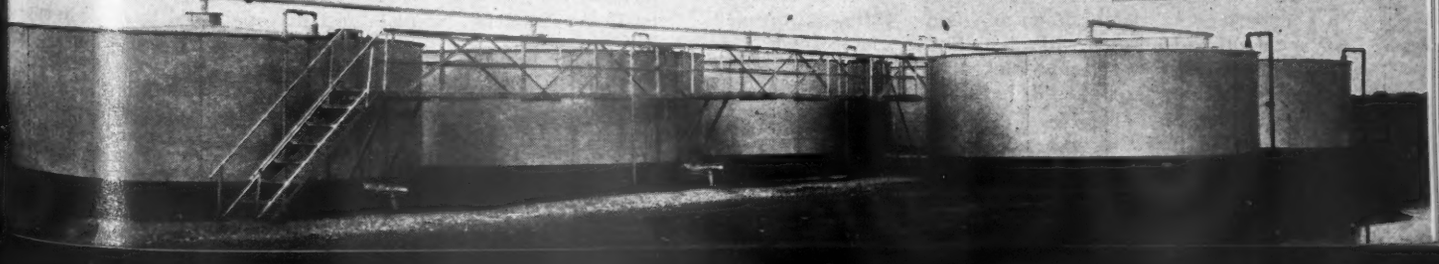

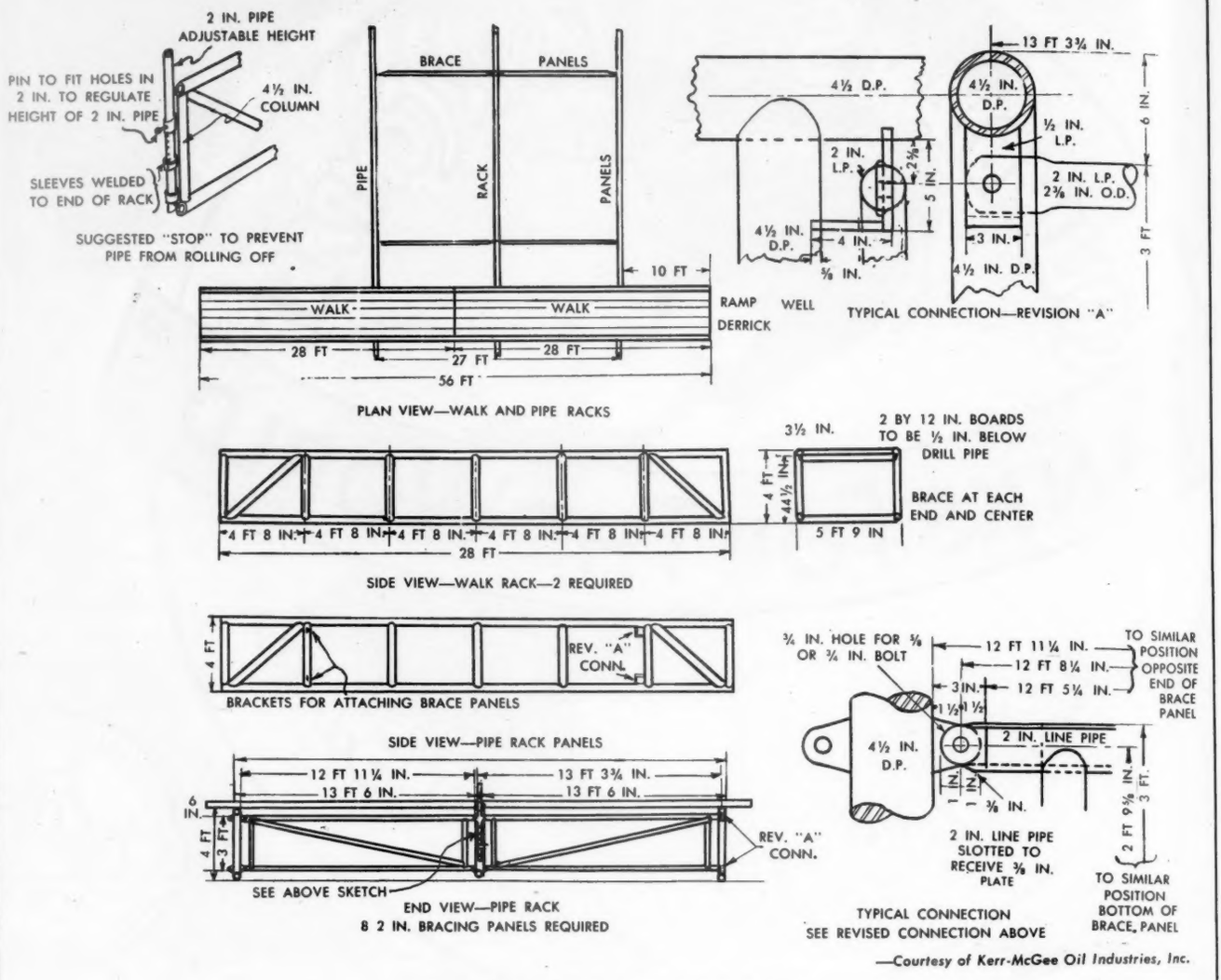

—Courtesy of Kerr-McGee Oil Industries, Inc.

FIG. 1. PIPE RACKS AND WALK RACKS.

Pipe Racks and Safe Handling of Pipe

In the drilling phase of the oil industry there are many mechanical routines that are changed and improved gradually but not drastically enough to bring out comment in the literature.

This is true in regard to handling of drill pipe on the drilling site and also in the various methods of constructing racks and stops for pipe.

Recently D. K. Gunderson of Regent Drilling Company, Ltd., Edmonton, Alberta wrote:

"The Canadian drilling contractors are experiencing too high an incident of accidents to workmen while handling pipe, particularly on the pipe rack. It is suggested that there should be some safe method used to secure or block the pipe to eliminate the possibility of it rolling accidentally.

"The method we use now is a piece of rope tied around the end of the pipe rack or any available chip of wood.

"If you could send me any ideas which would be adaptable for pipe racks constructed of drill pipe or constructed of timbers or a pipe stopper that can be used with either type of pipe rack, it would be greatly appreciated, and I would send the information forward to the government department directly concerned."

EXCLUSIVE

Because of the gradual change in methods we checked with some of the well known drilling companies for late information about how they handled pipe. We are indebted to G. Otis Danielson, chief drilling engineer, Kerr-McGee Oil Industries, Inc., for the drawing of pipe racks and walk racks in Fig. 1. He said that the means for permanently installing a "stop" to prevent drill pipe and casing from rolling off the racks, is sketched in the top left corner and adds that he believes the adjustable 2-in. pipe could be made to operate inside a 4½-in. column, instead of in sleeves as shown.

Safe drill pipe handling is described

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automatic seal,
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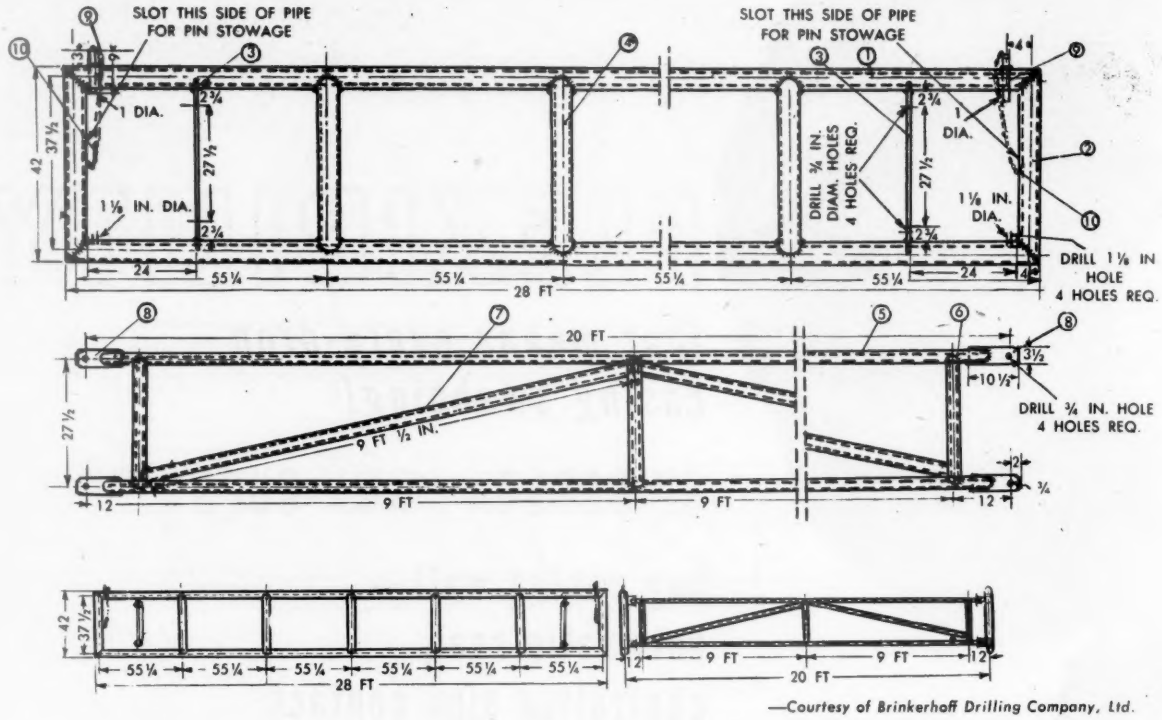

SLOT THIS SIDE OF PIPE FOR PIN STOWAGE
SLOT THIS SIDE OF PIPE FOR PIN STOWAGE
1 DIA.
1⅛ IN. DIA.
DRILL ¾ IN. DIAM. HOLES 4 HOLES REQ.
DRILL 1⅛ IN HOLE 4 HOLES REQ.
28 FT
20 FT
9 FT ½ IN.
DRILL ¾ IN. HOLE 4 HOLES REQ.
9 FT
12

—Courtesy of Brinkerhoff Drilling Company, Ltd.

FIG. 2. CASING RACKS.

No.	No. Req. L.H.	No. Req. R.H.	Dia.	Stock Sizes Thick.	Stock Sizes Width	Length	Description	Mat.
1	2		4½			28'	DRILL PIPE	STEEL
2	2		4½			42	DRILL PIPE	STEEL
3	2			½	3½	36	PLATE	M. ST.
4	5		4½			37½	DRILL PIPE	STEEL
5	2		2			19'	2 in EXTRA STRONG PIPE	STEEL
6	3		2			27½	2 in EXTRA STRONG PIPE	STEEL
7	2		2			9'0½"	2 in EXTRA STRONG PIPE	STEEL
8	4			½	3½	10½	PLATE	M. ST.
9	2		1			9	ROUND	M. ST.
10	2					24	CHAIN ⅛ lb	STEEL

as follows by H. H. Madley, mechanical engineer, Santa Fe Drilling Company:

"A. Steel pipe rack runners are always covered with a layer of wood so that there is never metal to metal contact between the pipe and the rack. Each tier of pipe is separated by wood stripping.

B. "Vee" shaped wood chips are generally used to secure each tier of pipe and are securely wedged in against the pipe and nailed to the wooden stripping.

C. The most important means of preventing pipe handling accidents is through education of the men in the safe way and the right way of handling pipe. It is safe to say that nearly all pipe handling accidents are caused by carelessness."

A. J. Heiser of Brown Drilling Company offers the following suggestions:

"On our racks we place a bolt through the end of the pipe racks to block the pipe from rolling. Steel clamps could be used for the same purpose. We admit that we still use wood chips in many cases as stoppers.

"On most of our equipment we are now using pipe bins. By utilizing these bins, the handling of drill pipe is reduced considerably. The basic operation is as follows: Each joint of pipe is removed from the bin with a tong clamp and a cat line. The cat line swings the pipe out of the walk, which eliminates pipe rolling. The bins also provide storage space for the pipe, saving considerable time in moves from one location to another, because the pipe is only handled once and that is when laying it down preparatory to moving out. We estimate that the bins save us about twice the time as the conventional rolling system, which, of course, give us a saving in rig time and reduction in accidents."

Fig. 2 shows a drawing of casing racks which the Brinkerhoff Drilling Company, Ltd., uses in Canadian operations. Burr Reding, Brinkerhoff field superintendent, says that his company considers these pipe racks and stoppers one of the safest. ★ ★ ★

Alberta Wants Private Development of Oil Sands

The Alberta government announced a policy on prospecting reservations and leases designed to "encourage immediate development" of the province's bituminous sands on the Athabasca River in northeastern Aberta, which are believed to hold the world's largest known oil reserve.

Mines Minister N. E. Tanner said licenses will be issued for geophysical or subsurface geological exploration for a fee of $25 and a cash deposit of $1000 as security that operations will conform with Alberta regulations.

The maximum area to be included in a prospecting permit will be 50,000 acres and an applicant will be limited to one permit. The fee will be $250 and a rental of 5 cents an acre will be charged for the first year. In addition, a deposit of $50,000 will be required to guarantee the carrying out of a satisfacory exploration program. Private companies showed interest in the government terms of development although some objected to limitation of acreage covered by one permit.

OIL OPERATIONS OF THE LONG BEACH HARBOR BOARD

RICHARD SNEDDON*

Oil wells and ships are the colorful combination that has made Long Beach one of the richest and most interesting towns of its size in the United States.

ONE of the most interesting oil operations in the Los Angeles basin is that being conducted by the Long Beach Board of Harbor Commissioners in the Wilmington field, which for some 13 years has been the Number One California oil producer and has in the meantime enriched the city tremendously. Harbor improvements that have been made possible by this development have greatly enhanced the port facilities and have frequently excited coastal cities in other sections of the United States into intensive studies of the total process and its accomplishments. Beginning with a small strip of land, about five acres in extent, the Board has enlarged its interests by reclamation, and otherwise until now, it has under its jurisdiction over 1400 acres of land on which are more than 700 wells with a daily yield of 55,000 bbl, and an additional 245 acres operated by Richfield Oil Corporation for the City of Long Beach and producing about 12,500 bbl of oil a day. The Board is also responsible for the operation of 76 Upland wells, drilled by various contractors for the several lessors on a conventional basis under which the royalty goes to Long Beach.

The Wilmington field in its entirety as of the present moment covers an area of approximately 7000 acres, lying between the center of Wilmington on the west, and the Los Angeles County flood control channel on the east. The expression "as of the present," is used advisedly, because the field will doubtless in the future have more reclaimed land on which drilling will be further extended to the south and east.

The area is unique in a number of respects. It has a multiplicity of producing zones, but until comparatively recently the scarcity of drilling sites and city-imposed drilling restrictions of various sorts precluded the use of ordinary methods of development. These very obstacles, however, gave impetus to the institution of an extremely modernistic conception of petroleum exploitation, and eventuated in the adoption of directional drilling on a scale hitherto unknown in California. Indeed, they were responsible for the acceleration of all manner of technical ingenuities that might otherwise have taken much longer to perfect.

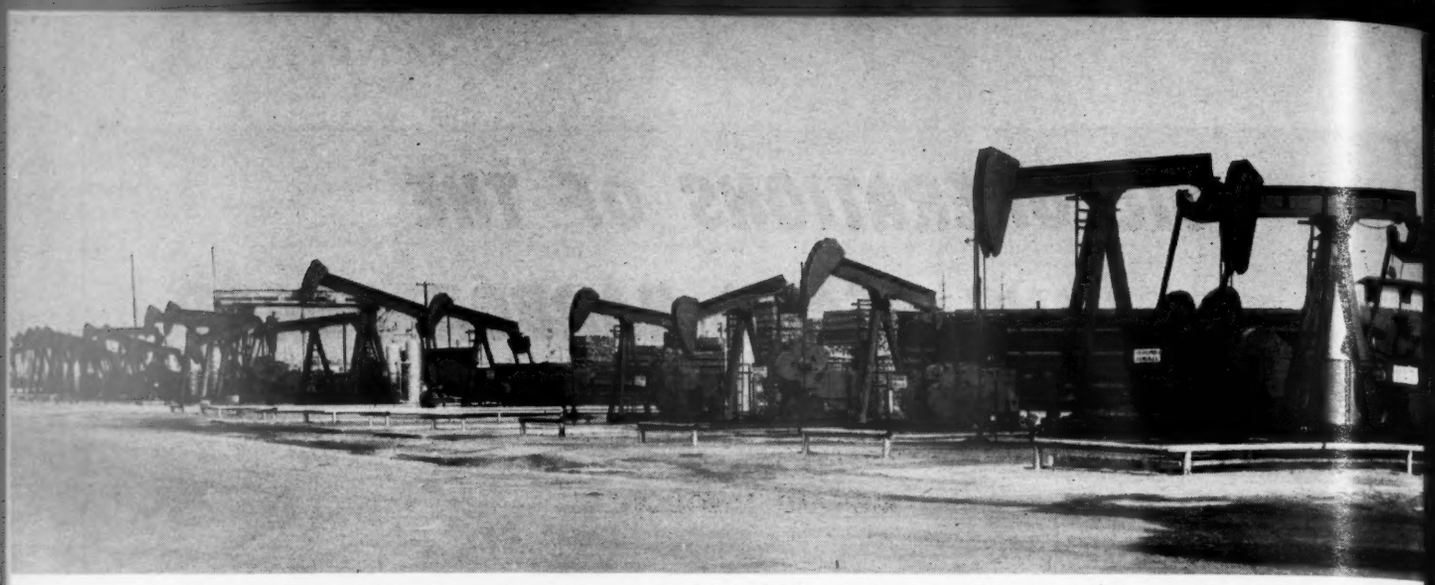
In addition to the restrictions and obstacles already mentioned, a large number of wells in the field have suffered crippling damage due to compaction and subsidence of the land in certain areas. Resident engineers, as well as those employed in a consulting capacity, have had a rare opportunity to study shear and stress effects, which have caused no little concern to the property owners and have simultaneously excited some pretty constructive thinking about terrestrial slippages, what they can do to oil wells, and what should be done about them! Remedial measures for now, and preventive measures for the future are the problems that have exercised the experts; and practical problems of this type are always productive of real progress. At least they tend to crystallize ethereal ideas and reduce them to some semblance of solidity.

The first commercial well in the Wilmington field was General Petroleum Corporation's Terminal No. 1, which was drilled following a thorough seismographic survey of the area. It was completed on December 6, 1936, at a depth of 6814 ft, with a plug at 3625 ft. It came in for 1389 bbl of 20.5 API gravity oil daily, from 500 ft of zone. It was located at the Wilmington end of the field, and it precipitated a sizable boom that has not quite subsided yet. In 1937, however, Long Beach opened up for drilling all privately owned properties on Terminal Island, the mainland north of Seaside Boulevard, and that portion of its lands west of the Los Angeles County flood control channel.

Operations in this southeastward direction indicated that production might

*Pacific Coast Editor.

EXCLUSIVE



This continuous string of pumping units on Long Beach Oil Development operated property is a familiar site in the Harbor area. The Harbor Department has over 700 producing wells that come under the supervision of the Department's Oil Division.

also be obtained from submarine areas in the southwest, owned by the city, and in early 1939, contracts were signed with Long Beach Oil Development Company to develop the tidelands area in what are known as Parcels W.X.Y. & Z. In 1944, two more parcels were added, ZI and J, and in 1947, the Richfield Oil Corporation signed an agreement to develop Parcel A, which is also tideland. All these parcels total slightly over 1650 acres. Long Beach city is the largest property owner in the Wilmington field. Union Pacific Railway runs second. Properties of the latter are being developed by E. B. Hall and Company through an agreement in some respects similar to that existing between Long Beach and the Long Beach Oil Development Company, and Richfield.

In return for its services as operator for the Board of Harbor Commissioners, Long Beach Oil Development Company receives 14.45 per cent royalty from the sale of the oil it produces. The remainder, less operating expense accrues to the benefit of the Harbor Department and the city. Richfield, as an additional operator, receives 5.9 per cent royalty on the sale of oil it produces with the balance, less operating expense, also going to the city. It might be noted in this connection that the Richfield agreement was made at a time when that company was not in such an advantageous position productionwise as it is today; that is, before it was boosted by Cuyama to fifth place in the list of state's producers. The agreement was entered into by Richfield to assure an adequate supply of crude for its future refining requirement.

This row of completed wells with cellar grids at ground level on Richfield operated Parcel A is an indication of the good housekeeping.

The geological structure of that part of the Wilmington field so far exploited is a faulted anticline, plunging to the northwest and southeast. It is divided into six main structural blocks by five faults that trend in a northerly direction across the axis of the fold. The situation is further complicated by minor faulting in each of the blocks. Eight major producing zones are recognized. These are isolated by zonal segregation in multi-zone wells or by production in single zone wells. Completions in which major zones are broken down to sub-zones with a well to each are becoming more common, however. In extreme cases some of these are producing from single more or less homogeneous sands, 30 to 50 ft thick. This type of development is the result of uneven reduction of zone pressures in adjacent sands, formations of secondary gas cap, and irregular water invasion.

Depth ranges and general characteristics of the zones are shown in the following tabulation:

Baash-Ross News

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A kelly is one piece of rig equipment that is probably more easily damaged when NOT in use than while in operation. Improper storage, or poor support while transporting, can easily bend a kelly so badly as to make it unusable—particularly at modern high table speeds. And once bent it is difficult to restraighten a kelly to its original accurate alignment.

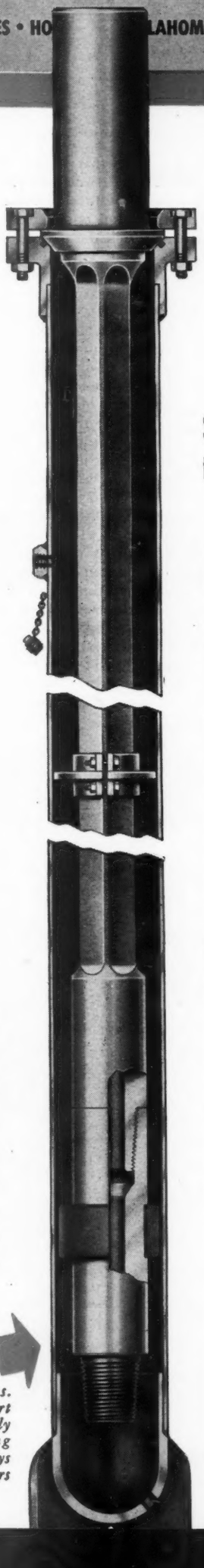
Here's the kelly protection you need, both on and off the rig—the BAASH-ROSS KELLY SCABBARD. In fact, the Kelly Scabbard is even more than its name implies, for it is also a portable rat-hole *complete with drilling bit and leak-proof circulation passages!*

NOTES FOR ORDERING

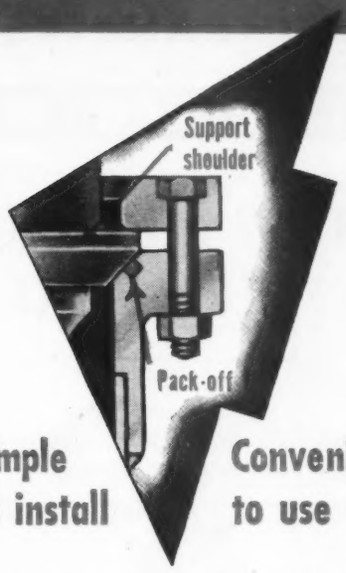
- The Baash-Ross Kelly Scabbard can be used with all types of kellys—square, hexagon, octagon or other types.
- It should be ordered long enough to accommodate the kelly saver sub so no breaking of this connection is necessary.
- All the new Baash-Ross kellys can be ordered with integral lock-ring machined on the kelly, together with the complete Kelly Scabbard attached for shipping.
- Kellys now in use can be easily equipped with a Kelly Scabbard by simply welding a split lock-ring to the upset.
- The Kelly Scabbard is available in two basic types—one to fit plain kellys and the other with sufficient clearance to accommodate kellys with rubber protectors as illustrated. Also, both types can be supplied either with integral drag-type drilling bit as shown or with a bit sub for attaching any desired type of bit. State choice.

OVERSEAS OPERATORS

While a Baash-Ross Kelly Scabbard makes vital savings on *any* drilling program, it is virtually indispensable on overseas operations where transportation and storage facilities are particularly hard on kellys. The Kelly Scabbard is a shipping and transportation "container" as well as a convenient, portable rat-hole!



Illustrated is the Baash-Ross Kelly Scabbard providing sufficient clearance for kellys having rubber protectors. Note centralizing support that maintains accurate kelly alignment. A closer-fitting type is also available for kellys where no rubber protectors are used.



Simple to install **Convenient to use**

As shown above, a double-tapered shoulder is provided on the kelly (either *integral* on new kellys, or *welded* onto older kellys). The Kelly Scabbard not only locks to and is supported by this ring, but also packs-off against it to permit high-pressure circulation through the drilling bit at the bottom without leakage at the top. *Note that no easily-damaged threads are used for connecting the Scabbard and kelly!*

WHEN THE KELLY IS NOT IN USE it remains locked and protected in the Scabbard at all times—in storage, during transportation, and on the pipe rack. The kelly cannot become damaged by careless handling or by improper support because of the rigid protection provided by the Kelly Scabbard!

After moving Scabbard assembly into rig, the kelly can be *permanently* attached to the swivel until completion of drilling. *At no time need the swivel be removed when connecting or disconnecting the Scabbard!*

WHEN RIGGING UP, the Scabbard remains around the kelly and provides a means of both drilling and "casing" the rat-hole in *one* simple operation. Since the Scabbard is equipped with a bit at the bottom, complete with circulation holes, and is tightly packed-off around the tapered ring, full circulation can be maintained through the kelly while drilling the rat-hole, without leakage around the top of the Scabbard.

WHEN READY TO DRILL THE WELL, after completing the rat-hole, it is only necessary to loosen the nuts from the studs and split lock-ring that holds the Scabbard to the kelly. The kelly can then be withdrawn from the Scabbard for drilling operations and, by replacing the split ring to form a protective seat, the Scabbard can be used as a rat-hole throughout all the subsequent drilling operations!

WHEN MOVING OUT after drilling is completed, it is only necessary to reconnect the kelly and Scabbard by means of the simple split lock-ring. Circulation can then be established around the outside of the Scabbard, thus loosening it for quick and easy withdrawal. After removing the Scabbard assembly the kelly, of course, remains inside throughout all subsequent handling, transportation and storage operations until again installed on the next well. *It's simple, convenient, and the ultimate in long-life protection for your kellys!*

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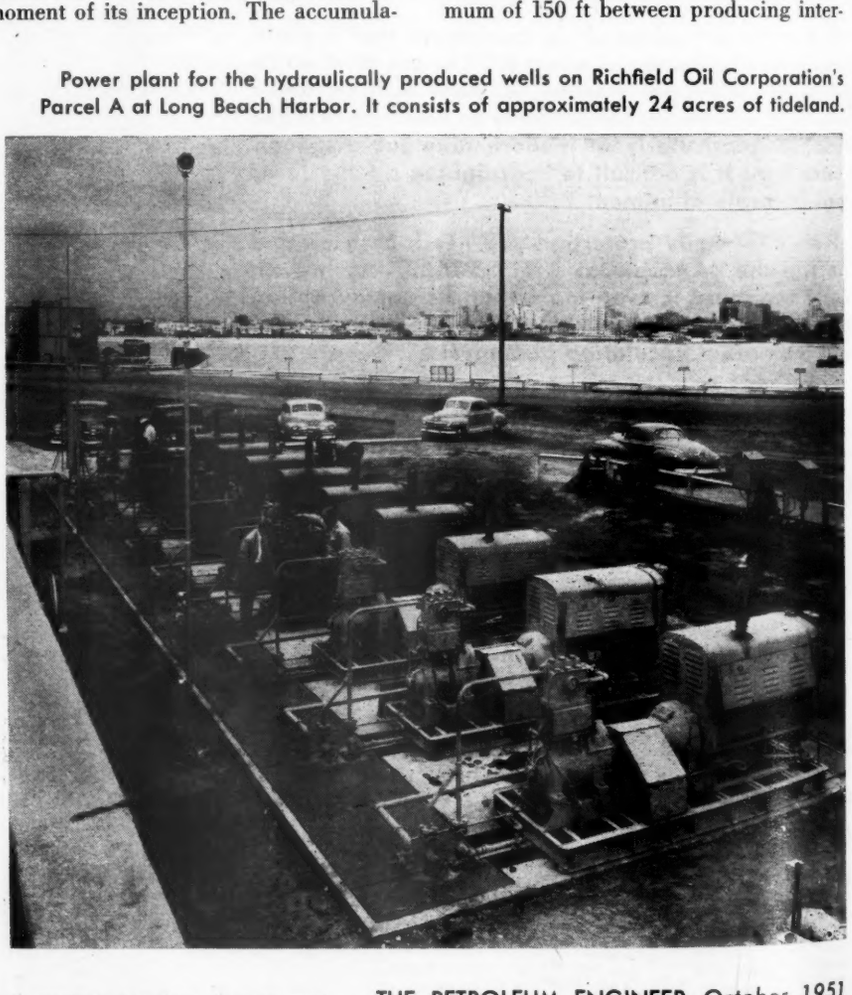
Zone	Depth Range to top of zone	Thickness	Per cent sand	Perm Md	Por. per cent	F.V.F. approx.	Grav. range
Tar	2100 – 2500	275 ft	42	1600	40	1.25	12 – 16
Ranger	2300 – 3150	475	20	1600	34	1.20	12 – 23
Upper Term	2800 – 3500	550	50	700	32	1.15	14 – 25
Lower Term	3350 – 3800	525	35	500	32	1.20	22 – 30
Union Pac.	3800 – 4000	550	20	275	30	1.30	25 – 30
Ford	4500 – 5000	1000	20	150	25	1.40	29 – 31
237	5350 – 5900	300	35+	150	25	1.40	28 – 32
Conglom.	5560 – 6000	10+	—	—	—	—	30+
Schist	6000+	—	—	—	—	—	30+

With this rather brief discussion of structure and producing zones, it will be easy to understand that successful operation is a highly technical business in which the process of directional drilling has acquired the status of a fine art. All wells on lands under the control of the Harbor Board are drilled by contract, with Long Beach Oil Development Company acting for the Board under the supervision of the Harbor Department oil division. The land that is being developed by Richfield Oil Corporation, however, is on city property, and the agreement is directly between Richfield and the city. It consists of 245 acres, and under the terms of the agreement on this parcel, Richfield acts for the city of Long Beach, its operations also being supervised by the Harbor department. The Long Beach Oil Development Company is responsible for the operation of six parcels, as already indicated, totaling 1406 acres.

Undoubtedly, one of the main reasons for the unusual drilling success in such a broken structure is that this field is one of the few in the world that has had the benefit of electric logging from the moment of its inception. The accumulation of sub-surface data thus obtained has helped immeasurably in the exploitation of the field. Other hole surveys, mainly directional and drift, have also enabled the engineers to do a remarkable job of pin-pointing completion areas. Single shots must be taken at intervals of not less than 100 ft from top to bottom, with the first 300 ft for surface pipe usually straight hole. In general, removable whipstocks and knuckle joints have been used to acquire the desired directional and drift trends, but the driller in every instance is held to very confined cylindrical clearances in dangerous spots, and despite the close surface spacing, fouling of other wells has been almost non-existant.

Up to 1945, the minimum required surface distance between locations was 150 ft. In that year an amendment to the state regulation was made, permitting wells to be more closely spaced for the purpose of directing them to producing zones that could not be reached with perpendicular holes. There was no change in the basic stipulation of one acre per well and a spacing minimum of 150 ft between producing inter-

Power plant for the hydraulically produced wells on Richfield Oil Corporation's Parcel A at Long Beach Harbor. It consists of approximately 24 acres of tideland.



vals in the same zone, but it was the change in the surface requirement that modified the entire course of operation. When this requirement was first relaxed, a spacing of 25 ft was adopted in a number of instances, but these are now being split and new wells are being drilled at 12½ ft intervals. Wells in new areas are currently spaced at 11-ft intervals. Richfield's latest wells alternate with spacings of 10 and 15 ft, with interlocking cellars, and it is interesting that 95 per cent of the Harbor Department wells are drilled in batteries with such close spacings as those described.

This type of drilling operation is a very economical one in many ways. With the wells situated in line at extremely close intervals the crews can set up for new projects in quick time and with much less transportation of materials and equipment. It is seldom necessary to dismantle the rigs, which are simply winched along the line from one site to another on skids. Some idea of the efficacy of this system is disclosed by the fact that the Long Beach Oil Development began with 12 rigs that have drilled over 600 wells plus more than a hundred redrills. Richfield has used four rigs only to drill 88 holes. When the operation was begun, it was thought necessary to drive pilings to support the rigs, but it has since been found that they can be based on matting without danger of settling. The land on which most on the locations are spotted is hydraulic fill, and it is possible that even this process has markedly improved since its initiation and that the fills are now in consequence more substantial than were the early ones.

The completion of shallow wells in the Tar, Ranger, and Upper Terminal zones was accompanied by considerable sand trouble in the beginning, and it is now customary to prepack the oil string, consisting of 6⅝ in. liner inside of 7⅝ in. perforated sheath, using 6-8 gravel. In addition, extensive use is now being made of the pump pack, that is, setting the 6⅝ in. liner, conventionally slotted but with no sheath, and pumping gravel around the outside in an oversize hole, 16 in. casing centralizers being used to center the pipe.

In the first 50 wells, a surface string of 18⅝ in. casing was cemented at about 350 ft, this was followed with an 11¾ in. water string, and the well was completed with an 8⅝ in. liner. At the present time the surface string is usually 13⅜ in. or 12¾ in. followed by an 8⅝ or 9⅝ in. water string, and completion is usually with a 6⅝ in. liner or a 5½ in. sometimes being used.

The mud program has been subjected to considerable change since operations were first begun. All early wells were drilled and completed with clay water-base mud only. Currently, however, treated muds are used extensively to control water loss and keep the bore hole in good condition, and when advisable, oil-base muds are used for completion. It is worthy of remark that although some of the wells are as much as 65 deg off perpendicular, and most of

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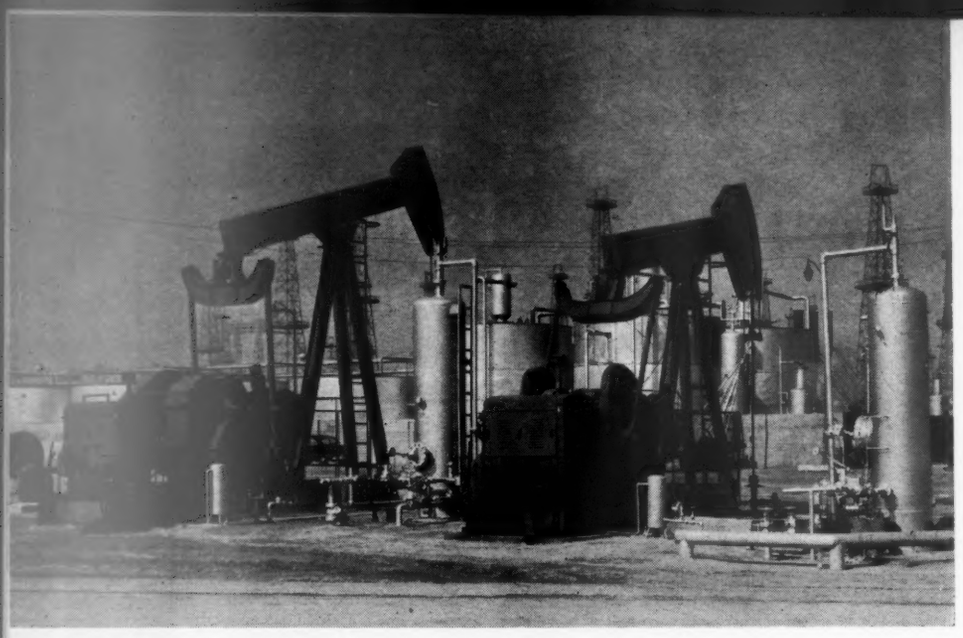

These two older wells also illustrate the orderliness with which operations are conducted. Everything is scrupulously clean and safety is a prime consideration.

them are acutely directional, the techniques employed have been so well perfected that the drilling process has presented little difficulty. The maximum distance of producing bottom from surface locations is 3700 ft in one of the Richfield wells. Directional veering begins at varied depths, depending on the site of the well, and has been carried on with singular success. On two occasions only have other wells been contacted. In the first one the casing in the contacted well was ruined, but in the other instance the driller felt that the bit was on solid iron and backed off before any damage was done.

Production has also been handled with little trouble excepting the remedial measures that were necessitated by subsidence and earthquake damage. That story has already been told in *The Petroleum Engineer* and there is no need to repeat it. It may be remarked, however, that subsidence is still taking place and is still causing the engineers no little anxiety. Actually, 75 per cent of the originally damaged wells have been returned to production either from the same zones as formerly or from other zones. The other 25 per cent remain unrepaired and there has been a partial abandonment of the deeper zones. It seems to be the consensus that the slippage is progressive and takes place along a lubricated, tilted, stratigraphic lamination.*

It can be said, however, that no well has been abandoned because of low production resulting from normal depletion. For the first two or three years all wells came in flowing, but most of them are now on the pump. The only treatment normally required before the wells are placed on production is a displacement with oil to get rid of excess mud. The major production problems are bottom hole gas separation and sand intrusion, but both of these contingencies have been adequately cared for, the first by the installation of packer-type gas anchors and larger and more efficient surface equipment; the second, by slowing down the pumping rate.

The wells on the LBOD operated area are mainly produced by rod pumps and have shown a surprisingly low incidence of rod failure considering the directional nature of the holes. Replacement of rods has been very light. This is largely due to the use of rotators that help prevent spot wear on both rods and tubing. One corrosion hot-spot has been found but this appears to have responded nicely to treatment with inhibitors. The pumping wells on the Richfield operated property are both rod and hydraulically lifted and they, too, have continued to yield in good condition and quantity with no reported difficulty. Both properties present an interesting contrast with the derrick-bristling Signal Hill that lies immediately to the north. The LBOD producing wells are characterized by neat rows of counter-balanced surface pumping units. The Richfield area shows no surface indication other than the row of grids covering the pits that house the bottom-hole hydraulic self-surfacing pump controls.

Such emulsion as is present in the oil is easily removed by chemical treatment at the well, and no great storage facilities are required since all crude is moved out within 24 hours of being produced. Gaging, testing, and sampling are supervised by an independent organization acting for the Harbor Department and city. A part of the operating agreement is that the operator shall find buyers for the oil, and needless to say, there has been no lack of buyers.

Future development of the lands under Harbor Department jurisdiction is, of course, dependent on a number of things, such as availability of sites, scarcity of steel, reclamation of further lands, laws and regulations, etc., but it seems reasonably certain that some 300 or 400 additional wells will be drilled before presently accessible sites are all used up. There is, indeed, no real reason why the program of development shouldn't continue far into the future. Long Beach and its people benefit in a very substantial way by these operations, and their continuation should

*Long Beach experienced another slight earthquake on August 16, 1951, which knocked out of commission, at least temporarily, 25 Union Pacific, 2 Signals, and 3 Richfield wells.

Well spacing has been reduced in recent wells to intervals as small as 11 ft and 95 per cent of all Harbor Department wells have been spaced between that and 15 ft.

CAN CRATERING BLOWOUTS BE PREVENTED?

Records show that most blowouts that crater are due to failure of the cement job to hold back the well pressures behind the casing after Blowout Preventers are closed!

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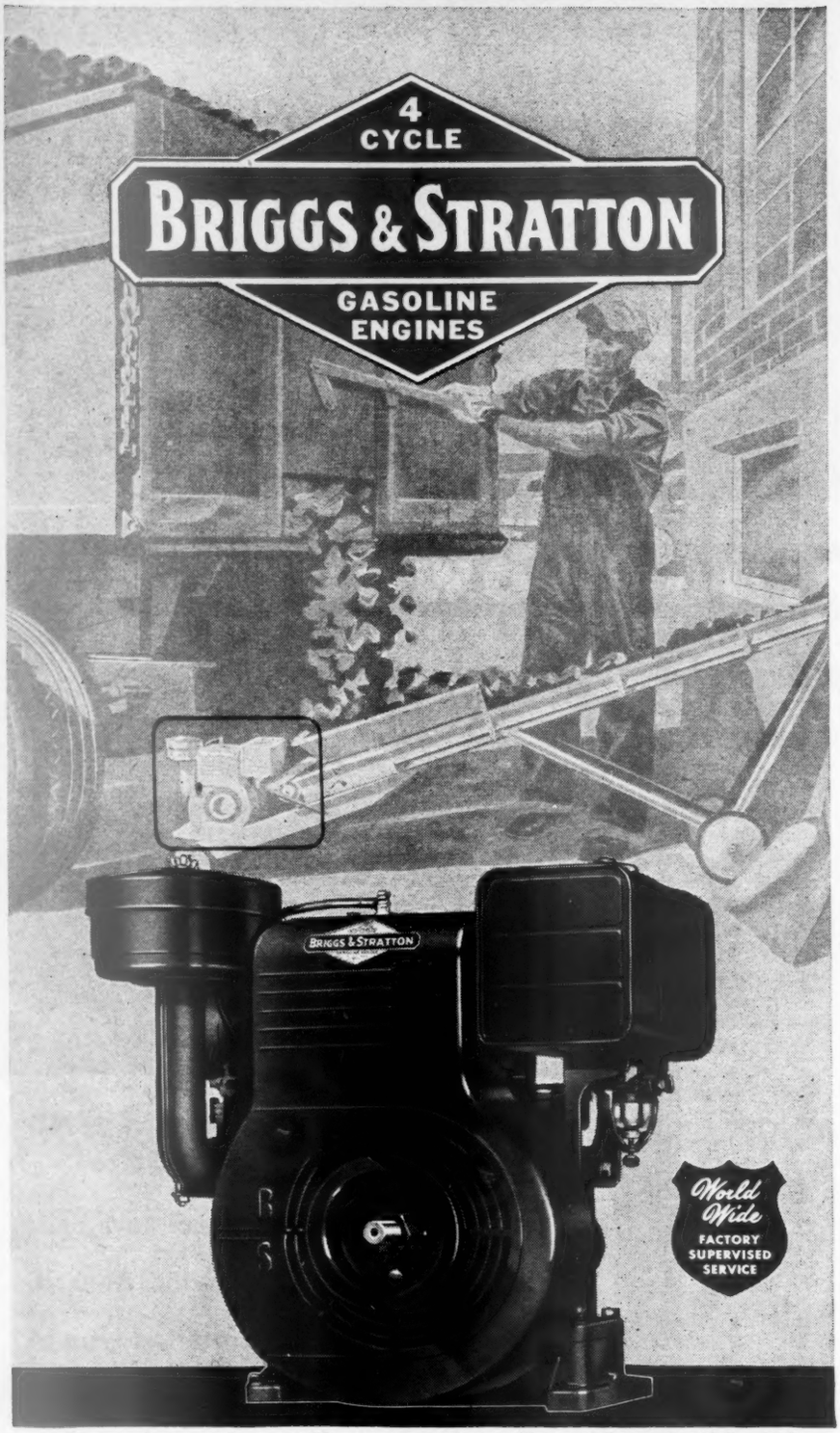

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In the automotive field Briggs & Stratton is the recognized leader and world's largest producer of locks, keys and related equipment.

eventuate in further immeasurable good. The city is already one of the most attractive in the west, and present and projected improvements should make it even more so. With a current total of approximately 67,500 bbl a day of production from the Harbor Department operations alone, the city is in excellent financial condition. With its share of royalties on these and other producing properties in the Wilmington and Long Beach fields, it is rapidly becoming one of the richest cities of its size in the United States.

The Long Beach Board of Harbor Commissioners must be given full credit for an admirable administration of its oil affairs. Under the presidency of W. R. "Frosty" Martin, who has occupied the top spot on the five-man Board for 12 years, and has just recently been reappointed to the Board and re-elected its president, the oil operation has been, and is, in experienced hands. Frosty has for the past 50 years been engaged in the diverse phases of the oil industry in all areas of the continent and he has a full understanding of the techniques of oil exploitation and production. He has been ably assisted in his current term by M. W. Daubney, vice president; R. D. Elliott, secretary; and Emmett M. Sullivan and John P. Davis, commissioners. This quintet has been responsible in a most pronounced way for the orderly and profitable exploitation of the 1406 acres of tidelands falling under its own immediate jurisdiction as well as the 245 acres of city property operated by Richfield Oil Corporation.

In order to process its oil interests in the most effective way, the Board has set up an oil division, the managerial staff of which is as follows: M. D. Hughes, chief petroleum engineer; Frank J. Hardesty, development engineer; George Hilty, production engineer; William Smith, geologist; George August, reservoir engineer; Sam Miller, gas engineer; Ted Courson, petroleum auditor. These men are all widely experienced and well regarded in their respective fields, and they have done a fine job of implementing plans, correlating efforts, and, in general, supervising the whole program in a manner that redounds to the benefit—present and future—of Long Beach and its citizens as well as to the credit of themselves.

The entire operation is different, at least from anything in the west, and there is no evidence at the moment of any deceleration in the development plans. Millions of dollars have been spent to create sites for oil wells where none was available before. Millions more will be spent, and although there is some occasion for alarm in the continuation of the subsidence effect, we are optimistic enough to believe that both remedial and preventive measures will be found. Meantime, operations being highly profitable are highly modernistic in character. They have already contributed much to the shaping of future exploration, drilling, and production techniques. ★ ★ ★

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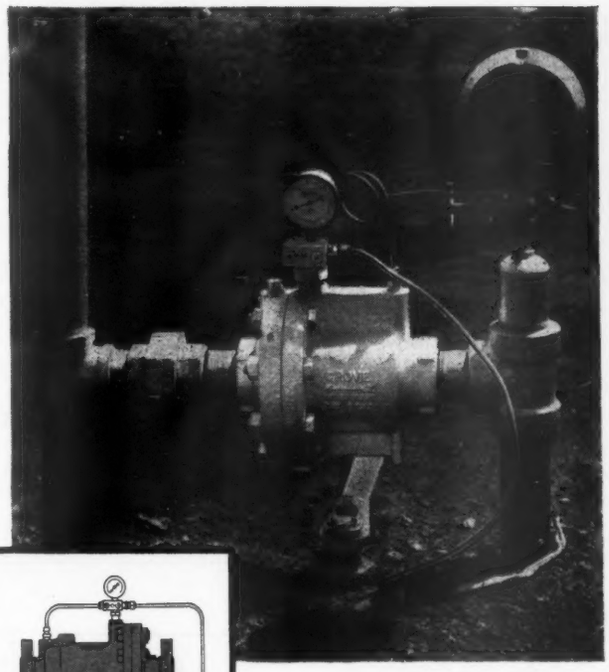
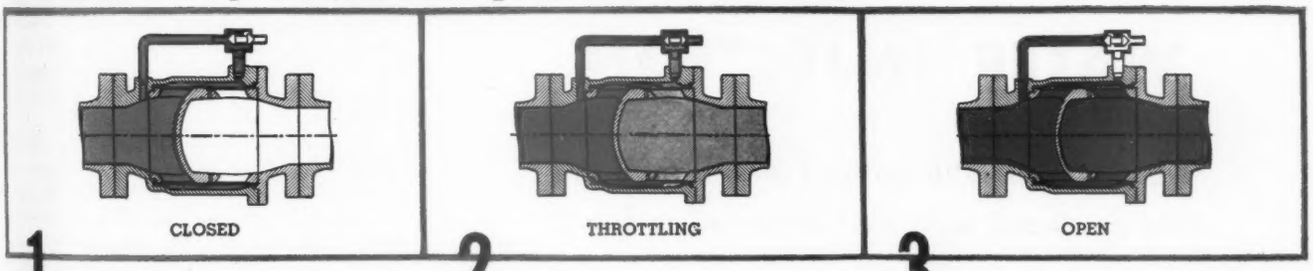


A Model 888 Grove Flexflo Reliever on Separator Gas Line. Pressure loaded operating cylinder is ground insulated against ambient temperature changes.

Here's why: *flexflo* lets pressure do the work--



1 The only moving part in the Flexflo Valve is a tough Buna N tube stretched over a cylindrical slotted metal core. When closed, line pressure from within, tending to force tube off core, is opposed by equal jacket pressure. Tension of the tube itself forms a positive, bubble-tight seal. The tube conforms to uneven surfaces and is hence unaffected by foreign matter or erosive wear.

2 As jacket pressure is reduced, line pressure begins to roll the tube off the core, opening the valve. Throttling is smooth and even. The Flexflo reacts instantly to the slightest pressure variations, compensating automatically for surge or shock impulses. Stability at all flow positions is accurately maintained. Fluttering and chattering are reduced to a minimum.

3 When all jacket pressure is removed, the tube is forced completely off the core and the valve assumes its wide open position. Full flow capacity with minimum pressure drop is assured. As Flexflo employs no hinge-pins, guides or other metallic moving parts, no troublesome problems of corrosion or wear are encountered. It cannot stick, wedge or slam.

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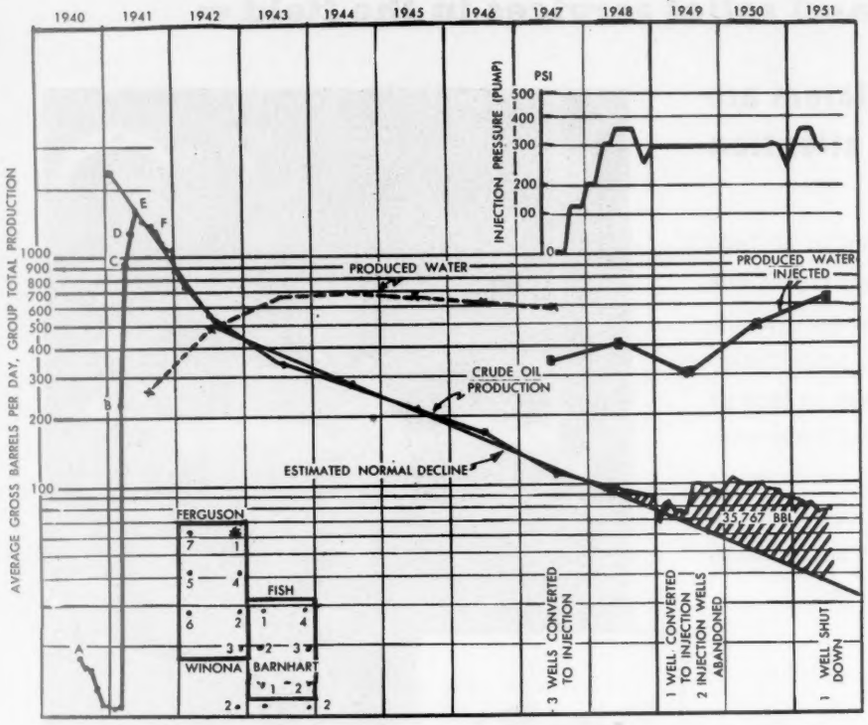


A. Ferguson Well 1 completed.
B. Ferguson Well 2 completed
C. Ferguson Well 3 completed, Fish Wells 1 and 2 completed, Barnhart Well 1 completed.
D. Ferguson Wells 4, 5, 6, 7, completed. Barnhart No. 2 completed.
E. Fish Well 3 completed.
F. Fish Well 4 completed.

FIG. 1. Ferguson-Fish-Barnhart field production chart.

WATER INJECTION

In a reservoir with natural water drive the fluid produced with oil is returned to sand.

THOMAS P. HARRIS

LOWER Calvin sand production was discovered in the Fish pool, Seminole County, Oklahoma, in February 1941 by the Mid-Continent Petroleum Corporation's Well No. 2 W. Ferguson, through perforations in the casing from 1478 to 1493 ft. The initial production was 300 bbl daily of 28 gravity oil on the pump.

The field was quickly developed and by September 1941, consisted of 19 pumping wells. Five dry holes were drilled outlining the area of saturation. Initial productions varied from 40 to 370 bbl daily.

The lower Calvin sand found here averages 27 ft in thickness and varies from a maximum of 40 ft in the best wells up structure to 10 ft on the edge. Unfortunately, no core analyses were made of the several cores taken. An examination of drilled samples indicates a clean, coarse grain sand and the initial production of the wells indicates a highly permeable condition.

Natural gas in small quantity was produced from the wells and the average gas-oil ratio equalled 200 cu ft per barrel in the early stages. This gas tested 0.04 gal per minute and was not rich enough for gasoline plant consumption. It has, however, served lease facilities as fuel during the life of the pool.

An active edge and bottom water drive was evidenced from inception of the pool, most wells producing some water immediately and all wells produced water within one month after completion.

This article concerns 120 of the 160 productive acres in the pool, which is shown in subsurface on Fig. 2. The dry holes shown, found the sand as indicated by the minus elevation, which for the most part had small shows of oil accompanied by large volumes of water. The wells situated down structure quickly went on water in quantity as shown by tests made in January 1942, when Well No. 1 Fish, the highest well in the field tested 90 bbl of oil and 10 bbl of salt water daily, whereas, Well No. 7 Ferguson, the lowest well in the field, tested 10 bbl of oil and 75 bbl of water daily.

Fig. 1 (left) indicates the progressive incline of water production and decline of crude oil production. During 1946, Wells Nos. 1, 5, 6, and 7 Ferguson were shut down due to lack of sufficient oil to pay for pumping. Production of the balance of the property equalled approximately 150 bbl of oil and 600 bbl of water daily in April 1947, when the Oklahoma Corporation Commission was petitioned for permission to institute water flooding on the premises using this 600 bbl of produced water as an injection medium. Following favorable action by the regulatory body, Wells Nos. 1, 5, and 7 Ferguson were stripped of pumping equipment and converted to water injection.

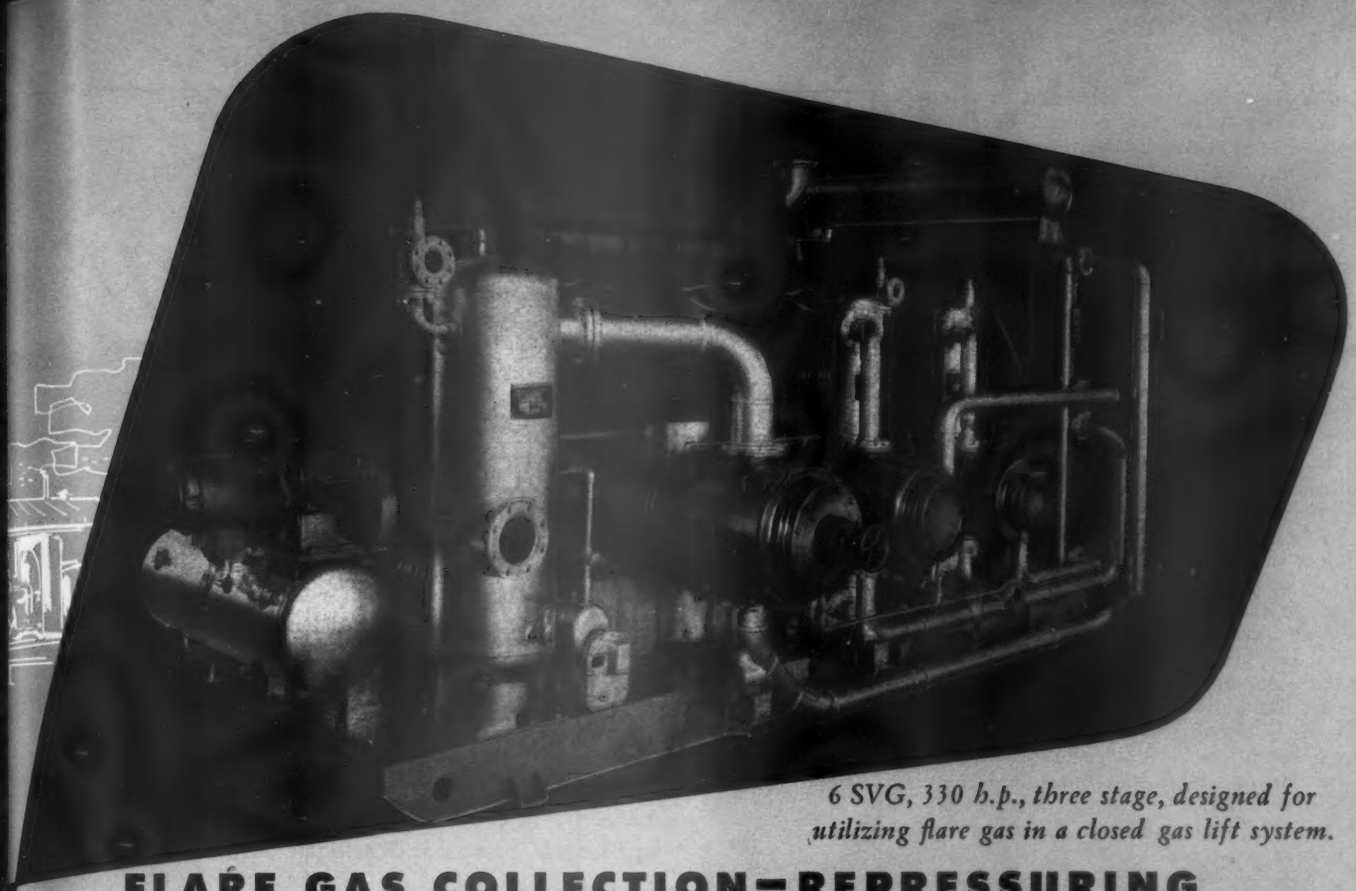
A 4-in. salt water gravity gathering system was installed over the property. Siphon connections were connected to the top of the receiving tanks, a 500-bbl tank erected for collection and a 4 by 6 in. Duplex, gas engine-driven pump installed for pumping the water into the injection wells. In order to exclude all possible air from the system, a 6 in. blanket of oil is held on top of the salt water in the 500 bbl tank. This closed system has worked remarkably well during the life of the project, no noticeable plugging having taken place in the injection wells.

During the first 90 days the three wells took the water at atmospheric top hole pressure. As the fill-up progressed the pressure gradually increased and stabilized at 300 psi, where with minor variations, it remains. Well No. 4

The Author

Thomas P. Harris began work for the Mid-West Refining Company at Casper, Wyoming, in 1923 after attending the University of California. He later worked for the Sinclair Crude Oil Purchasing Company in the Salt Creek and Teapot Dome oil fields. In 1927, he joined the Mid-Continent Petroleum Corporation, working in the Garber field. He has been superintendent of secondary recovery for that company since 1942. He is also a member of the AIME and API.

EXCLUSIVE



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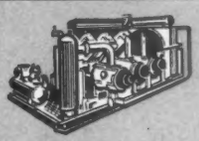

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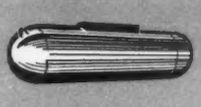
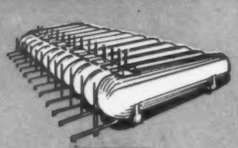


ANHYDROUS AMMONIA EQUIPMENT



PRESSURE BULK STORAGE

Ferguson has been converted to injection and Wells Nos. 1 and 7 Ferguson have been abandoned as the water front has advanced.

Twelve months after injection began, production of the group showed indications of leveling off and after 24 months, an increase was experienced that has continued to date. To July 1, 1951, a total of 35,757 gross barrels of oil have been recovered in excess of that amount expected through extrapolation of the normal decline curve based on experience prior to the initial injection date.

The question naturally arises as to whether this increased oil is secondary recovery oil that would not have been produced had no water been injected, or is it oil that would normally be produced by the natural water drive, the rate of production being accelerated by the injected water.

The writer is of the opinion that it is oil that probably would be produced if the economics of production were such that the wells could be operated to extremely low volumes of oil. Under present conditions and at the rates of production indicated, it is improbable that this oil would be recovered normally, therefore, it may be considered as secondary recovered oil.

This experience would seem to indicate that considerable oil may be recovered in many of our water driven reservoirs by the simple expedient of returning our produced water to the formation from which it originated. * * *

FIG. 2. Ferguson-Fish Pool, Seminole County, Oklahoma.

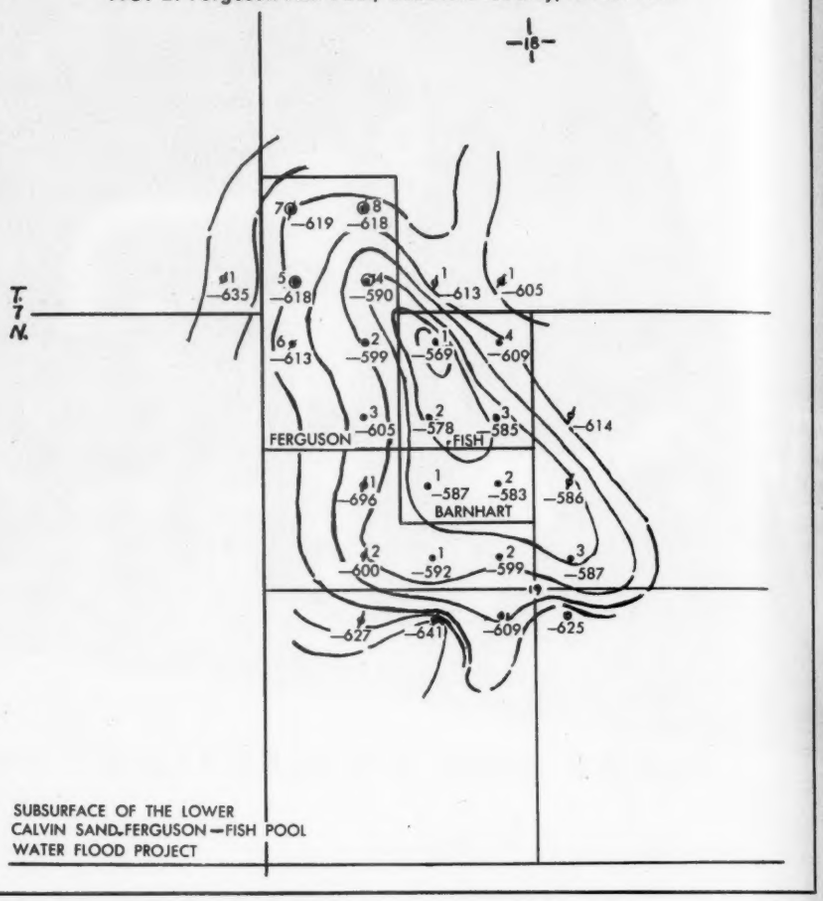


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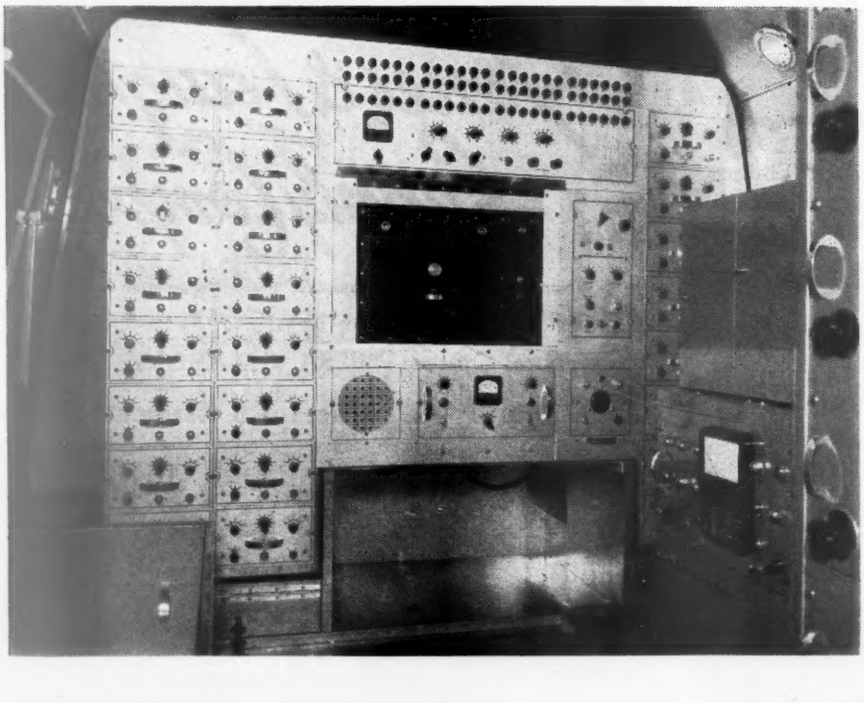
FIG. 1. FIELD RESEARCH UNIT.

A Seismic Research Laboratory on Wheels

New tool determines proper instrumentation and field procedure before a regular crew enters

W. E. PUGH

FIG. 2. INSTRUMENT INSTALLATION.



EXCLUSIVE

A "LABORATORY on wheels" is the latest tool to be used for more accurate and efficient seismic exploration, now being provided by Seismograph Service Corporation for the various oil companies and their exploration divisions. In essence, this tool consists of regular and special seismic-recording equipment for a pilot crew to operate in new or extremely difficult shooting areas, and also to conduct normal field tests or to carry out "trouble shooting" in areas where a regular crew is already operating. Its primary purpose however is the former; that is, the determination of the proper instrumentation and field procedure before a regular crew enters a new or difficult area. Fig. 1 shows a view of the research truck.

Manned by highly competent personnel, who are supported by the many years of experience accumulated by SSC's technical, supervisory, and managerial staffs, the Pilot Crew serves greatly to improve overall seismic results in quality, accuracy, and economy of operation. In general, the equipment consists of:

1. A standard 24-trace recording unit.
2. A 40-trace camera-oscillograph permitting multiple recording.
3. A bank of 4 flat response amplifiers.
4. A 4-trace variable area recording oscillograph on which is recorded the output of the flat response amplifiers.

Fig. 2 shows the instrument installation with the regular seismic amplifying and recording equipment in the background. The variable area recording equipment is located in the middle right foreground, while the flat response amplifiers are shown in the right foreground.

In the rear of the truck are a power-driven geophone cable reel and storage spaces for geophones, batteries, and miscellaneous equipment.

The Author

W. E. Pugh received degree in geological engineering in 1930 and an MS in geophysics in 1932 from the Colorado School of Mines. After a short term with the Plains Exploration Company, Denver, he joined Seismograph Service Corporation. He became a party chief, in which capacity he worked for five years before being made a supervisor in charge of interpretation. He was later made a research engineer and senior research engineer, which title he now holds.

He edited the "Bibliography of Organic Reefs, Bioherms, and Biostromes" in 1950 and the "Bibliography of Stratigraphic Traps" in 1951.

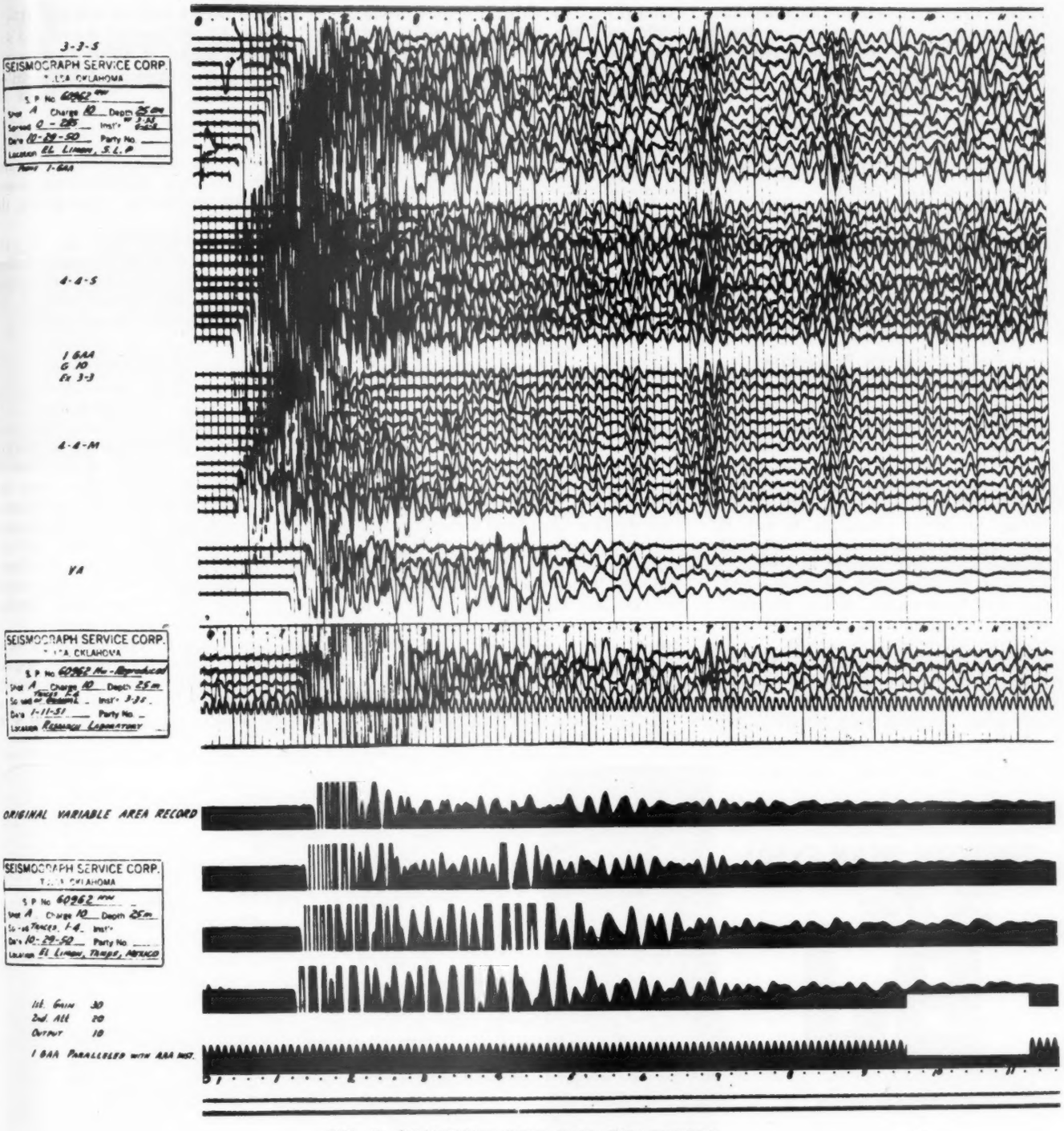


FIG. 3. COMPOSITE FIELD RESEARCH RECORD.

Regular Equipment and Special Features

Specifically, the regular seismic amplifiers are equipped with variable filters of the band pass type. Several types of geophones are available, including a swamp type and also a recently developed miniature type for multiple geophone arrangements.

In addition to the normal amplifier filters, additional filters are included as special equipment. These units are designed for installation into the regular seismic amplifiers, if their use is found advantageous.

A wide latitude in automatic volume control is available, as well as flexibility in mixing percentages.

The 40-trace camera unit is especially useful, allowing the simultaneous recording of unmixed and mixed records from the same geophone spread (see Fig. 3).

Flat Response and Variable Area Equipment

Certainly the most interesting and important portion of the special equipment, particularly from a research point of view, is the flat response, variable area equipment.

Using 4 low frequency (10 cps) geophones, which are planted alongside 4 regular geophones and connected to the 4 flat response (above 2cps) amplifiers, their outputs are recorded on a 4-trace variable area recorder. In effect, the latter is a recording oscillograph designed to translate electrical signals into corresponding amplitude variations on a variable area film.

These variable area films may be retranslated into corresponding electrical signals by means of the variable area reproducer, and then reproduced as normal seismic records. In other words, from one variable area film it is possible to obtain as many normal seismic rec-

ords as the regular seismic amplifier has filter variations. The interpretive advantages of such a system can hardly be overemphasized.

Usually (but not necessarily, as the reproducer can also be used in the field) the variable area films are sent to the research laboratory for reproduction, and subsequent detailed study and analysis of the reproduced records.

Some day, 24-trace *reproducible* types of records may be the normal product of seismic field operations. Surely, this sounds no more impractical today than the suggestion of a 24-trace continuous profiling field procedure might have sounded about 1930!

Field Research Procedure

In research, the application of the fundamental principle—**controlled experimentation**, or the changing of one variable at a time—must be maintained whenever possible. For example, if the filter setting and the shot depth are changed simultaneously, the cause of the change in record character, if any, is indeterminate, and therefore only one of these should be changed at a time.

To attain this single variable objective in field research, certain standard field procedures are set up and followed whenever circumstances permit.

In one of these procedures, 6 geophones are set out along the line of spread to be investigated. The 24 amplifiers in the research truck are then paralleled into 4 groups of 6 each, using a different filter setting for each group. The result, of course, is equivalent to that obtained from 4 separate shots at the same hole depth. Further, during the succession of shots in any one shot hole, one particular group of 6 channels is kept at a constant filter setting throughout all tests, thus maintaining as closely as possible the single variable principle. Of the remaining 16 camera traces, 12 are used to furnish mixed records for 2 of the 4 amplifier groups, while the remaining 4 are used to monitor the flat response amplifier outputs. The latter are also recorded simultaneously on the variable area film.

Another standard procedure often used is perhaps best explained by referring to Fig. 3, which is a composite record of the results obtained from a single shot in the El Limon area in the State of Tamaulipas, Mexico.

The top 12 traces represent the output of a 12 geophone spread with a certain filter setting. The next 12 traces represent the same geophone output recorded through a different filter setting. The third group of 12 traces uses the same filter as the second group with 50 per cent mixing. The last 4 traces of the 40-trace camera record show the monitored output of the flat response amplifiers, whose geophones are in the same locations as the top four of the first twelve traces.

The bottom record is the variable area representation of the output of the same four flat response amplifiers mentioned above with the bottom trace giving the timing control.

Inserted between the top 40-trace record and the bottom variable area record is a reproduction of the variable area record made in the laboratory, using the same filter as the top 12 traces.

Petroleum and natural gas provided 54 per cent of the nation's energy supply in 1950, reaching the staggering total of 19 quadrillion Btu's.

☆ ☆ ☆

Conclusion

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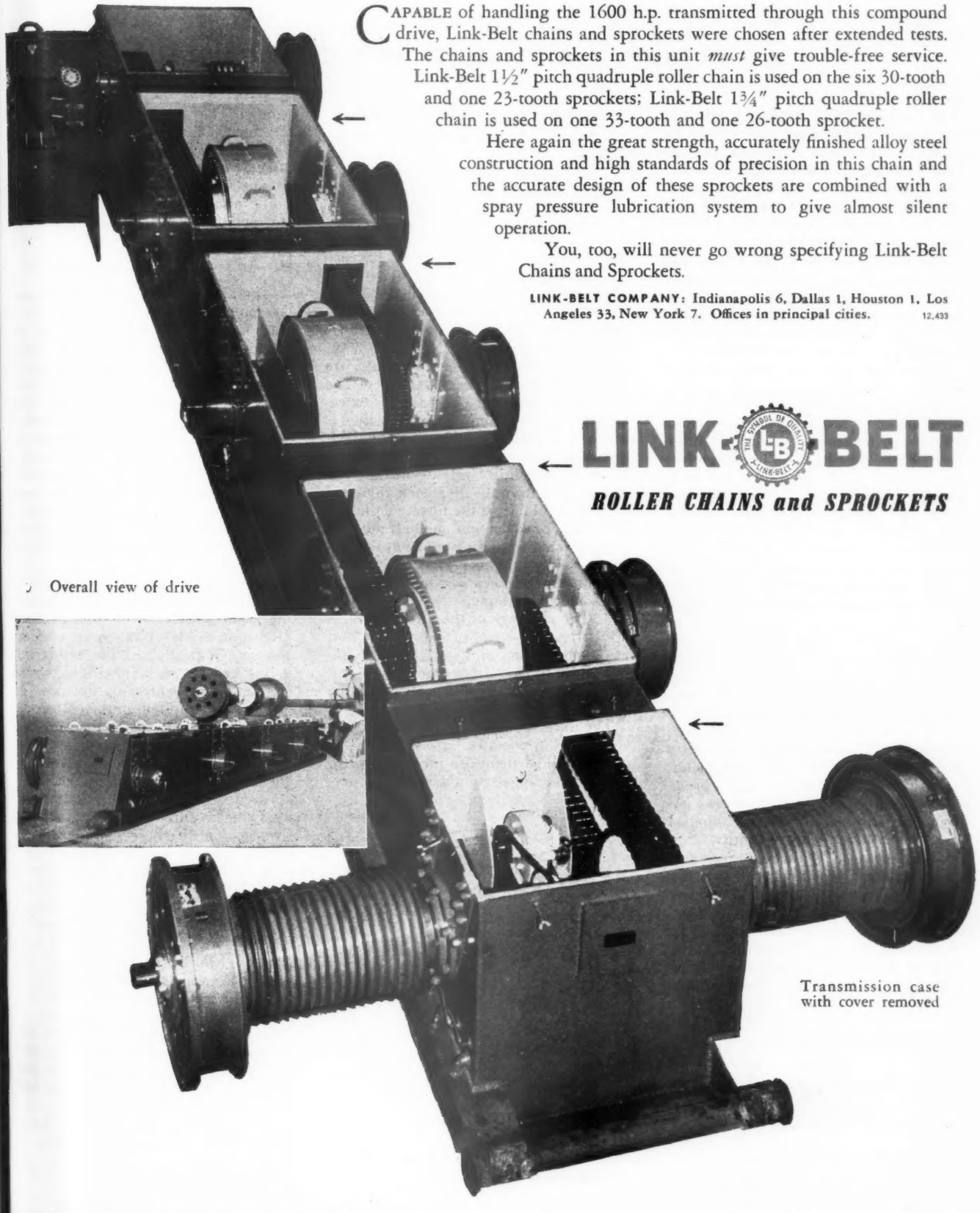

Overall view of drive

Transmission case with cover removed

Improved Drilling Fluid Filter Loss Tester

Besides being more accurate, new equipment is more convenient

J. F. CHITTUM*, M. B. STANDING*, W. T. CARDWELL, JR.*

THE present API standard filtration equipment[1] has a space under the filter paper in the bottom of the cell that can hold up a significant volume of filtrate. The actual volume of this space depends upon the distortion of the screen that supports the filter paper; the effective volume depends upon the manner in which the filtrate wets the screen and filter press bottom. The effective hold-up volume can vary from 0.1 to 1.5 cu cm. According to experience with graphical correction methods, the hold-up volume is usually about one cubic centimeter.

When high filter loss fluids are measured in the present tester, the hold-up volume is unimportant. An unknown variation of a few tenths to one cubic centimeter makes no practical difference. When low filter loss fluids, such as the modern emulsion fluids, are measured, the hold-up volume becomes significant. In the field, expensive chemical treatments are sometimes based on variations of tenths of a cubic centimeter and it is desirable that the observed variations represent real changes in the fluids being measured, not apparent variations due to changing hold-up volume. Finally, when fluids are measured, such as oil base fluids, and the filter losses are of the order of one cubic centimeter, measurements on the present standard tester have little value. It is impossible to make meaningful comparisons of fluids whose filter losses are in the range below one cubic centimeter.

Low filter loss fluids command premium prices, and it therefore seems important to be able to make meaningful measurements of the quantity that serves as one of the main bases for extra cost. There are two ways that ordinary filter loss measurements can be made more meaningful: (1) the measured values can be corrected for hold-up volume, and (2) the filter tester can be designed to make the hold-up volume insignificantly small and easily reproducible.

The Correction of Filter Loss Values

There are several accepted methods of making corrections in measured filter loss values. All of them are based on the well-established filtration formula:

$$v = K\sqrt{t}$$

where:

v = filtrate volume
K = constant, dependent on the temperature and pressure
t = time

The object of the correction in each case is to obtain the total filtrate volume that would have been collected in 30 minutes, if the filtrate had started to issue at zero time.[2] Some of the methods are given below:

1. The filtrate volume-time data are plotted on semi-square-root paper. The straight line through the points is extrapolated to zero time. Then the line is given a parallel displacement until it passes through the origin. The corrected value for the thirty minute filtrate volume is read from the displaced curve.[2, 3]

2. The volume of the filtrate collected at the end of seven and one-half minutes is subtracted from the volume at the end of the thirty minute period. The difference in the volumes is doubled to give the corrected volume.

3. The readings of the filtrate volume are taken at the end of one minute and at the end of 14 minutes. The first reading is subtracted from the second and the difference is doubled to give the corrected 30 minute volume.

The disadvantages connected with the correction procedures are readily apparent. All of them are inconvenient to use in the field, particularly for rig personnel. They are not useful for fluids of extremely low filter loss, even in the laboratory. To avoid the disadvantages of corrections, a new filter cell was developed that enables satisfactory results to be obtained, without the necessity of corrections, even for fluids of extremely low filter loss.

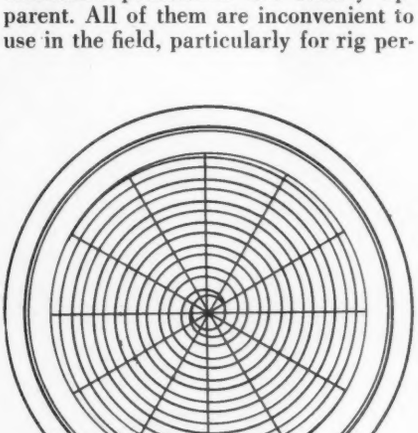

FIG. 1. Surface of the bottom plate of the new filter loss tester.

The New Tester

The filter cell described in this paper has only three separable parts. The top part is essentially like that of the present API standard tester. The middle, cylindrical part is of the same over-all dimensions as the corresponding present part. There are, however, slightly tapered channels cut in each end of the cylinder wall into which neoprene gaskets are recessed. Each channel is 9/64 in. wide at the top, 5/32 in. wide at the bottom, and 3/32 in. deep. The gasket for each recess is moulded of neoprene to fit the channel with 1/32 in. effective exposure. It is sealed in place with shellac.

The bottom part of the filter cell has been changed radically.† The plane surface that closes the bottom of the cell (the bottom plate) has been made into a filter paper support by cutting interlacing grooves in it for drainage of the filtrate to the central outlet tube.

The groove system in the bottom plate is the device that serves the purpose of decreasing the hold-up volume in the new cell. The inter-lacing grooves are cut according to whatever pattern is most convenient. A design that has been used successfully is shown in Fig. 1. Grooves of nearly semi-circular cross section are cut in the form of a spiral with 0.08 ± 0.005 in. between turns. A series of concentric circles would serve just as well and would be more convenient to produce in large scale manufacture. There are equally spaced radial grooves leading to the central outlet tube. The grooves are 0.005 ± 0.002 in. wide and 0.008 ± 0.002 in. deep. They are preferably deeper than they are wide. The outlet tube is 0.031 ± 0.001 in. in inside diameter and 0.750 ± 0.005 in. long. The total grooved out space under the filter paper is 0.005 ± 0.002 cu in., or 0.008 ± 0.03 cu cm.

In cutting the grooves in the bottom plate surface it is important to make the

*California Research Corporation, La Habra, California.
[1]References are at the end of the paper.

†Patent applied for, licensed to Oil Base, Inc., Compton, California.

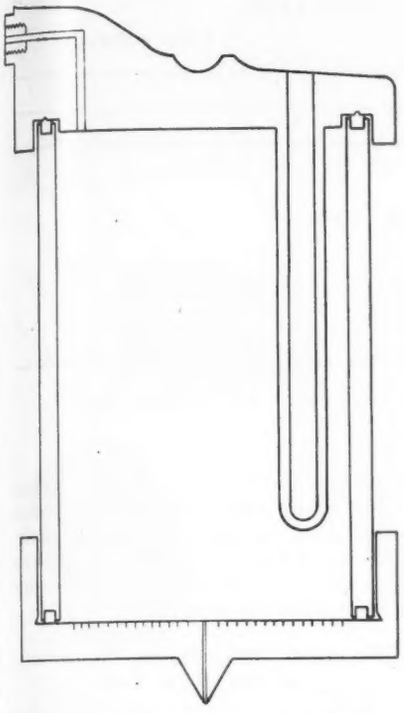

FIG. 2. Longitudinal section of the new filter loss tester assembled.

shoulders as square as possible to minimize the pressing of the filter paper into the grooves. The grooves should be free from obstacles that would hinder the flow of the filtrate. It is especially desirable to eliminate all the burrs that tend to be formed during machining so that there will be unimpeded flow of the filtrate at the intersection of the radial and spiral grooves.

The cell is assembled by simply placing the filter paper flat on the bottom plate, attaching the cylinder, pouring the fluid into the container thus formed and placing the top part in position. A longitudinal section through the tester is shown in Fig. 2.

Test Procedure

No special precautions are necessary in carrying out filter loss tests using the new cell. The procedure described in Section IV of the Recommended Practice on Standard Field Procedure for Testing Drilling Fluids[1] is followed with only minor changes. The parts of Item 41, which refer to gaskets and wire screen, may be disregarded. It is important to use a good grade of filter paper such as Whatman 50, which is about 0.005 in. thick and which has a permeability of about 0.01 darcy.

Test Results

The described filter cell has been in use in our laboratory for about four years. It has given completely satisfactory results on a large number of drilling fluids of different types. Sample data for quintuplicate filter loss determinations, made on each of eight different drilling fluids, are shown in Table 1. Results for each tester, the present API

TABLE 1. Comparative wall building tests at 100 F and 100 psi 30 min filtrate valves.

	Standard API tester			New filter cell		
Sample	Uncorrected	Corrected geographically by extrapolation	Corrected by doubling (14-1) min. readings	Uncorrected	Corrected geographically by extrapolation	Corrected by doubling (14-1) min. readings
A 1	0.0 cc	—	—	0.25 cc	0.25 cc	0.25 cc
2	0.0	—	—	0.27	0.25	0.25
3	0.0	—	—	0.27	0.28	0.32
4	0.0	—	—	0.32	0.32	0.31
5	0.0	—	—	0.39	0.40	0.43
Average	0.0			0.30	0.30	0.31
B 1	0.0	—	—	0.32	0.33	0.30
2	0.0	—	—	0.70	0.70	0.72
3	0.0	—	—	0.64	0.67	0.66
4	0.0	—	—	0.65	0.69	0.60
5	0.0	—	—	0.50	0.56	0.46
Average	0.0			0.56	0.59	0.55
C 1	1.4	2.0 cc	—	2.3	2.1	2.2
2	1.7	2.0	—	2.5	2.2	2.4
3	1.6	1.9	—	2.4	2.1	2.2
4	1.8	2.3	—	2.5	2.6	2.6
5	1.6	1.9	—	2.4	2.5	2.2
Average	1.6	2.0		2.4	2.3	2.3
D 1	4.2	5.2	4.2 cc	4.4	4.4	4.2
2	4.4	5.3	4.6	4.1	4.2	4.0
3	3.8	5.2	4.0	4.0	4.1	4.0
4	3.8	4.3	4.0	4.1	4.2	3.8
5	3.9	4.9	4.6	4.2	4.2	3.8
Average	4.0	5.0	4.3	4.2	4.2	4.0
E 1	3.7	3.9	4.0	4.4	4.5	4.4
2	3.5	4.0	4.2	4.1	4.3	4.4
3	3.5	4.0	4.2	4.3	4.4	4.2
4	3.5	4.1	4.0	4.3	4.5	4.2
5	3.3	4.2	3.8	4.3	4.3	4.2
Average	3.5	4.0	4.0	4.3	4.4	4.3
F 1	4.6	5.3	5.4	5.3	5.4	5.2
2	4.9	5.5	5.6	5.6	5.6	5.6
3	4.9	5.5	5.6	5.6	5.6	5.4
4	4.9	5.5	5.4	5.6	5.6	5.4
5	4.8	5.5	5.4	5.4	5.4	5.6
Average	4.8	5.5	5.5	5.5	5.5	5.4
G 1	5.2	5.7	5.6	6.4	6.9	6.6
2	5.7	6.4	6.2	6.5	7.0	6.6
3	5.7	6.8	6.6	6.6	7.1	6.8
4	6.0	6.8	6.6	6.6	7.1	7.0
5	6.2	7.3	7.4	6.7	7.2	7.0
Average	5.8	6.6	6.5	6.6	7.1	6.8
H 1	6.8	7.9	7.8	8.0	8.7	8.2
2	6.9	7.7	7.6	8.1	8.8	8.4
3	7.0	8.0	7.2	7.9	8.7	8.2
4	6.8	8.0	7.4	8.0	8.7	8.4
5	6.7	7.9	7.4	8.0	8.6	8.2
Average	6.9	7.9	7.5	8.0	8.7	8.3

A Oil base drilling fluid
B Another oil base drilling fluid
C Emulsion drilling fluid
D Lime starch fluid
E Pyro treated native clay fluid
F Quebracho treated fluid
G CMC treated brine fluid
H Another CMC treated brine fluid

TABLE 2. Comparative wall building tests at 150 F and 100 psi 30 min filtrate values using new filter cell.

Sample	Uncorrected filtrate volume cc	Volume corrected graphically cc	Volume corrected by doubling (14-1) min reading cc	Volume obtained by doubling 7½ min reading cc
J 1	3.6	3.5	3.4	3.6
2	3.6	3.7	3.3	3.6
3	3.6	3.6	3.3	3.5
4	3.6	3.6	3.4	3.4
5	3.7	3.7	3.4	3.6
Average	3.6	3.6	3.4	3.5
K 1	4.4	4.3	4.0	4.0
2	4.3	4.3	4.2	4.2
3	4.4	4.3	4.0	4.0
4	4.4	4.3	4.1	4.0
5	4.2	4.3	4.1	4.0
Average	4.3	4.3	4.1	4.0
L 1	6.0	6.0	6.2	6.2
2	6.3	6.2	6.2	6.8
3	5.9	5.9	6.0	6.0
4	5.9	5.9	5.8	5.8
5	6.8	6.7	6.8	7.2
Average	6.2	6.1	6.2	6.4
M 1	12.6	12.0	12.6	11.8
2	12.5	11.8	12.3	11.6
3	12.5	11.8	12.0	11.4
4	12.6	11.8	12.2	11.6
5	12.2	12.0	12.0	11.0
Average	12.5	11.9	12.2	11.5

J Pyro treated native clay fluid
K Starch fluid
L Calcium clay fluid
M Lime starch fluid

standard tester and the new tester, are reported: (1) as obtained uncorrected, (2) corrected by the graphical method, and (3) corrected by doubling the difference between the 14 minute and the one minute filtrate volume.

The reproducibility of measurements with the new cell is good. In addition, the uncorrected results agree very well with corrected results from the present standard tester.

Additional quintuplicate filter tests were run on each of four drilling fluids at 150 F. Table 2 compares the uncorrected and the corrected results. The last column of Table 2 shows a different kind of uncorrected result, a calculated 30 min value, obtained merely by doubling the 7½ min value. The agreement between this value and the 30 min value shows that with the new tester, which gives no large errors in the initial minutes of flow, it is possible to make an accurate estimate of the 30 min value from a short 7½ min test.

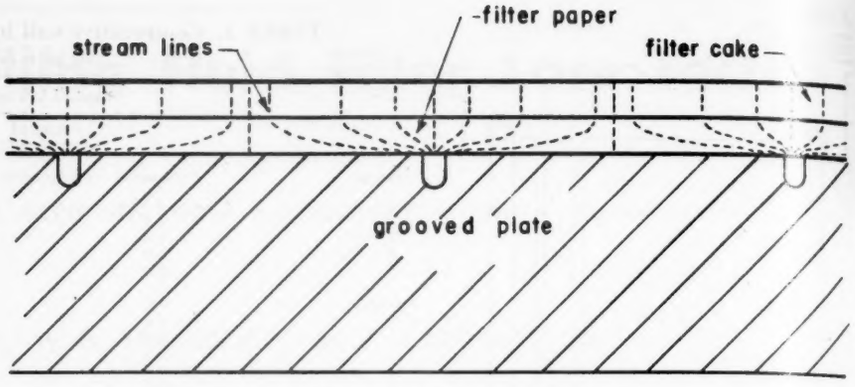

FIG. 3. A flow section of the filter cake, filter paper, and grooved plate.

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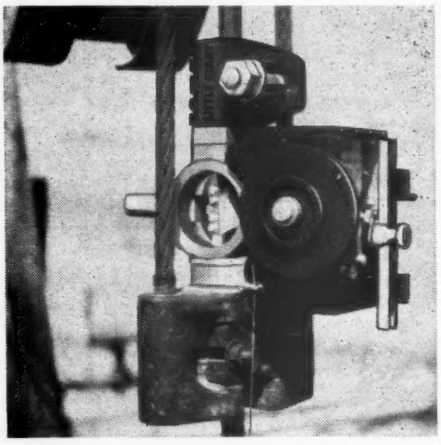

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Physical Reasons for Accuracy of the New Cell

The preceding part of this article has discussed the desirability of small hold-up volume. The design of a cell with small hold-up volume has been described, and results of tests have been presented. It is still possible, however, that the reader may wonder how the new filter cell can be as accurate as it is when flow out of the bottom of the filter paper is apparently so restricted. Ninety-five per cent of the filter paper area rests against flat metal. Evidently it was previously thought that the space underneath the filter paper should be as unobstructed as possible. The early filter cell of Williams and Cannon[4] had not only a wire screen below the filter paper, but had 19 holes underneath the screen for the escape of fluid to the outside.

It is now realized that after the first few seconds of filtration of a modern drilling fluid, the resistance to flow offered by the filter cake predominates over all other resistances in the system. It is unnecessary to provide obviously easy paths for the escaping fluid after it has passed through the filter cake. Mathematical calculations are given in the Appendix that demonstrate this point.

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Mathematical Appendix

The purpose of this appendix is to show mathematically that the obstruction at the bottom of the filter paper in the new filter cell has no significant

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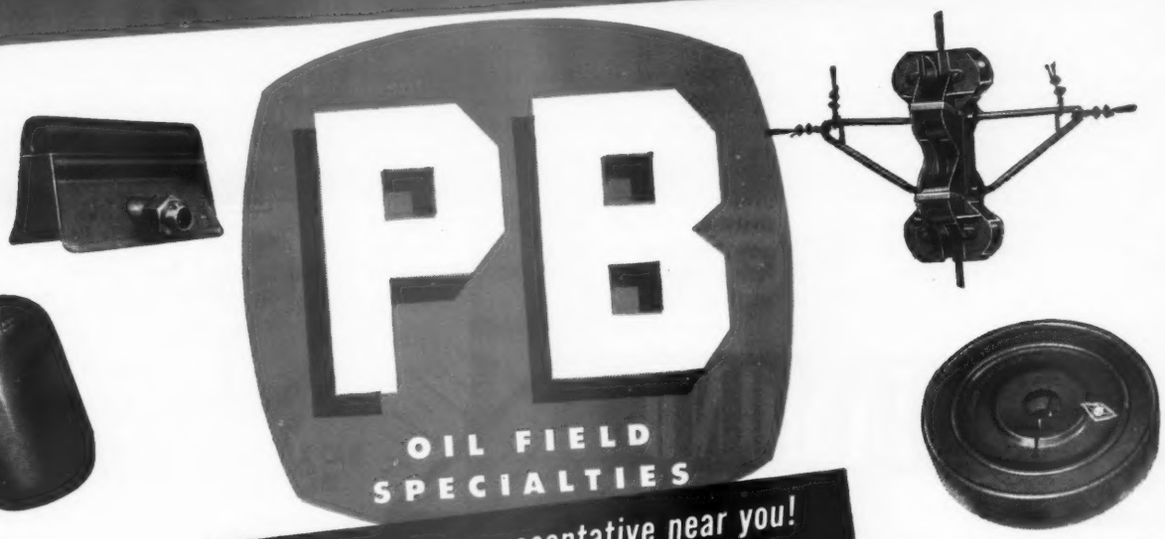

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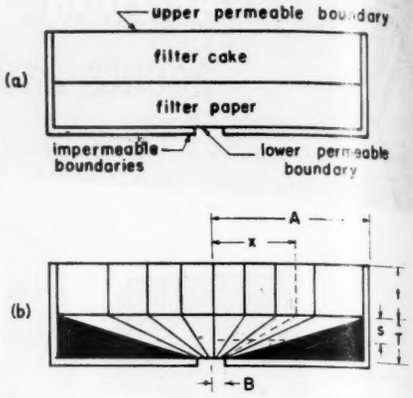
effect on the measurement made by the cell. It would be unreasonably difficult to prove this rigorously, but an approximate calculation can be made that suffices for practical illustration.

Consider Fig. 3, which shows a radial cross section between the radial grooves in the bottom plate. If the section of this figure is imagined to be a section of a system whose dimensions are the same in all planes parallel to the plane of the paper (a so-called two-dimensional system) it is possible to calculate the effect of the obstructed portions on the bottom of the filter paper. The answer must apply semi-quantitatively to the three-dimensional system from which the section of Fig. 3 is abstracted.

The section of Fig. 3 can be further simplified. It is apparent by inspection that the streamlines in both the filter cake and filter paper must be vertical at a position midway between two of the grooves. Because there is no flow across any such streamline, it is hypothetically possible to insert a very thin impermeable barrier in the position occupied by each vertical streamline without changing the flow on either side. It is possible also to consider each portion of the flow system between any two such positions as an independent flow section like that shown in Fig. 4a. The problem of calculating the flow conductivity at the bottom of the filter cell is now reduced to the problem of calculating the conductivity of this simple section.



(a) The unit flow section.
(b) Hypothesized lines of flow in the filter cake.

FIG. 4.

Even the flow section shown in Fig. 4a is difficult to handle by exact theoretical methods because it is composed of an upper and a lower part having different permeabilities. A limiting value, however, above which the conductivity of the section must lie, can be calculated easily.

The method of calculating the lower limit of the conductivity involves principles that have been used previously in calculating the average permeabilities of heterogeneous oil sands.[5] The flow within a hypothetical system is directed along arbitrarily chosen paths by very thin highly impermeable laminae. The paths are so chosen that their individual flow resistances are calculable, and consequently their combined conductance is calculable. It is known that the combined conductance so calculated must be equal to or less than the conductance of the actual system, which does not contain the laminae. If the hypothetical laminae are carefully chosen so that they closely follow streamlines that would exist in the actual system, the calculated conductance will be close to the conductance of the actual system.

In the case of the system of Fig. 4a, there are good bases for hypothesizing strictly vertical flow paths in the upper, less permeable part of the system. It is known that lines of flow going from a medium of high permeability, like the filter paper, into a medium of low permeability, like the filter cake, are refracted toward the normal to the boundary. (The ratio between the permeabilities in the present case is so high—10,000—that even a line that deviated from the vertical by as much as 89 deg 50 min would be refracted at the boundary to within 2 deg of the vertical.) It is less accurate, but still reasonable, to assume that the flow lines in the lower part, corresponding to the filter paper, are straight, and radiate from the small opening at the bottom of the section, as indicated in Fig. 4b, cutting off, or eliminating the triangular portions of the section beneath the extreme lines on the right and left hand sides. It is assumed for calculative convenience that the frac-

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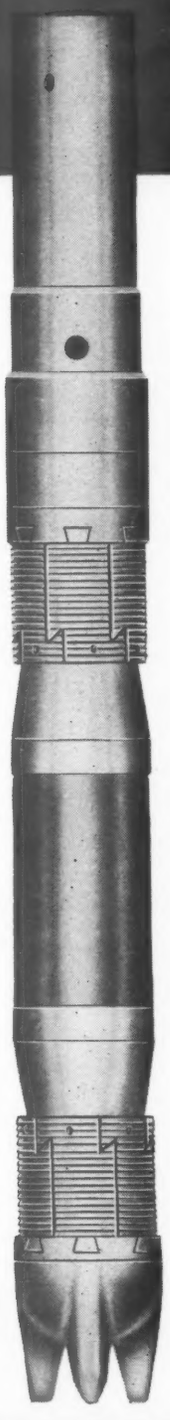

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tions into which any given line divides the bottom opening are identical with those into which it divides the boundary between the lower and upper parts of the section.

Fig. 4b shows the flow section divided into eight hypothetical paths. It is possible to hypothesize an infinite number of such paths and to calculate the resistances of the individual paths and the conductance of their combination, analytically.

Consider Fig. 4b. Let it be desired to calculate the resistance, r_x, of a flow path that terminates at the position, x, on the top boundary. Let the width of the path be $\triangle$ x. Then the resistance of the path will be given by Equation 1.

$$r_x = \rho_c \frac{t}{x} + \rho_p \frac{1}{x} \int_0^T \frac{ds}{\left[1 - \left(1 - \frac{B}{A}\right)\frac{s}{T}\right] \cos^2 \phi} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Where:

ρ_c = the specific flow resistivity of the upper part of the flow section (filter cake),
t = the thickness of the upper part of the flow section,
x = the variable distance measured from the middle of the flow section,
ρ_p = the specific flow resistivity of the lower part of the flow section (filter paper),
T = the thickness of the lower part of the flow section,
A = the half width of the flow section,
B = the half width of the bottom opening of the flow section,
s = the variable distance measured downward from the boundary between the upper and lower parts,

$$\phi = \tan^{-1}\left[\frac{x\,(1 - B/A)}{T}\right]$$

Upon integration Equation 1 becomes

$$r_x = \rho_c \frac{t}{\Delta x} + \rho_p \frac{T}{\Delta x} \frac{A \ln A/B}{(A-B) \cos^2 \phi} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The conductance of this same path will be the reciprocal of the resistance:

$$C_x = \frac{1}{r_x} = \frac{\Delta x}{\rho_c t + \rho_p T \frac{A \ln A/B}{(A-B) \cos^2 \phi}} \quad . \quad . \quad . \quad (3)$$

Let the width, $\triangle$x, become vanishingly small.

Then the total conductance of the section becomes:

$$C = 2 \int_0^A \frac{dx}{\rho_c t + \rho_p T \frac{A \ln A/B}{(A-B) \cos^2 \phi}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$= \frac{2TA}{(A-B)} \int_0^{\tan^{-1}\frac{A-B}{T}} \frac{d\phi}{\rho_c t \cos^2 \phi + \rho_p T \frac{A \ln A/B}{(A-B)}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Which upon integration becomes:

$$C = \frac{2TA}{(A-B)\sqrt{K_2^2 + K_1 K_2}} \tan^{-1} \frac{(A-B)\sqrt{K_2^2 + K_1 K_2}}{T(K_1 + K_2)} \quad . \quad . \quad . \quad (6)$$

Where

$$K_1 = \rho_c t$$

And

$$K_2 = \rho_p T \frac{A \ln A/B}{(A-B)}$$

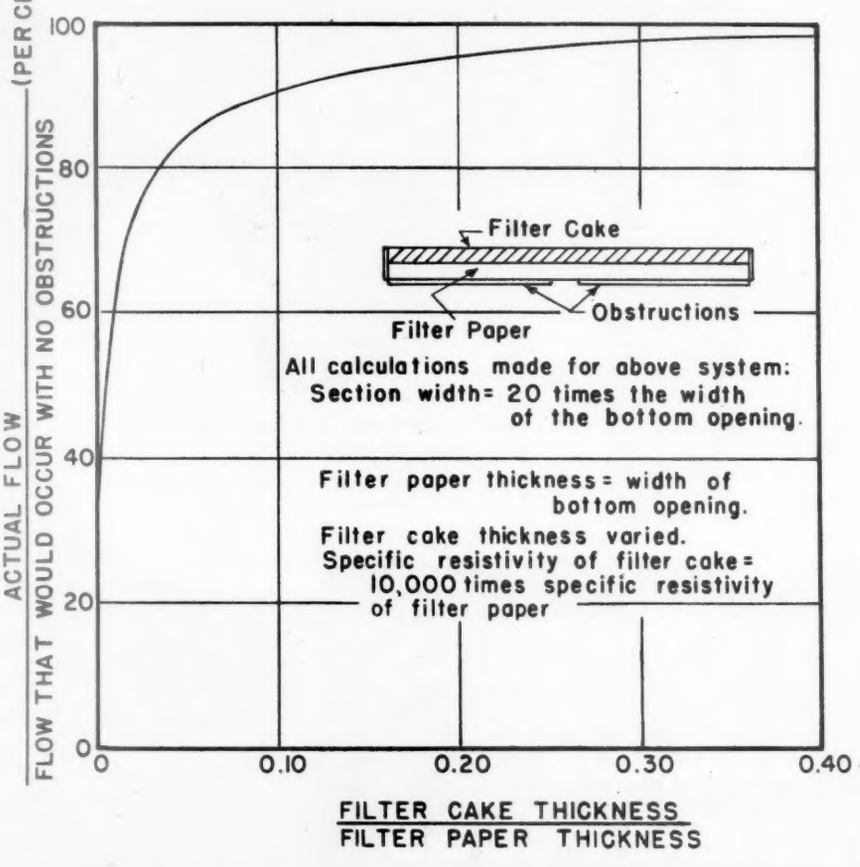
A check on the derivation of Equation 6 can be obtained by evaluating the expression when the width of the bottom opening, B, is allowed to approach the width of the entire flow section, A. The result is

$$C_B = A = \frac{2A}{\rho_c t + \rho_p T} \quad . \quad . \quad . \quad (7)$$

which is obviously true by inspection. Equation 6 has been used to calculate the results shown in Fig. 5. The ratio of the actual flow rate through the section to the rate of flow that would occur with no obstruction is plotted against the ratio of filter cake thickness to the filter paper thickness. The constants selected for the calculations are those that approximate the conditions when a No. 50 Whatman filter paper is used in the new filter cell for the testing of a drilling fluid having an API filter loss of 5 cu cm. The ratio 10,000 for the specific resistivities of the filter paper and filter cake is conservative, since the new filter cell will find its widest use in testing drilling fluids whose API filter losses are less than 5 cu cm, and whose filter cakes are more than 10,000 times as resistant as the filter paper.

It is obvious from Fig. 5 that, as soon as the filter cake has bulit up to a small fraction of the thickness of the filter paper, its resistance is the controlling factor in the flow process. The obstruction at the bottom of the filter paper in the new filter cell has a negligible effect. Since the filter cake will be built up to the thickness of the filter paper in a few seconds, only during those few seconds would it be possible to detect a significant reduction in the flow rate due to the obstrucion. After a minute, the difference in the filtrate volume caused by the 95 per cent obstruction would not be detectable by currently used methods of measuring the filtrate volume. ★ ★ ★

FIG. 5. A comparison of the flow through the obstructed filter with flow through an unobstructed filter.



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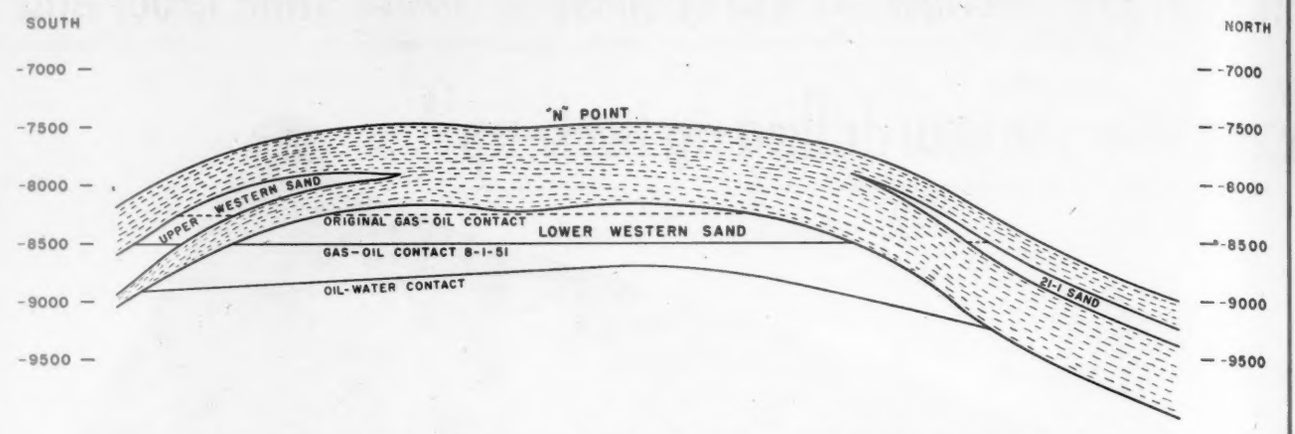

FIG. 1. Generalized north-south cross section, North Coles Levee Field, showing sand development.

Production History of Main Western Pool, North Coles Levee Field

W. J. TRAVERS, JR.* and F. T. LLOYD*

THE North Coles Levee oil field is situated on the floor of the San Joaquin Valley, approximately halfway between the cities of Bakersfield and Taft, California. It is one of a group of deep pools discovered in the years 1936 to 1939, largely as a result of seismographic exploration. Within the productive area of North Coles Levee the surface consists largely of flat, bottom lands comprising a portion of the delta area of the Kern River. The field derives its name from the levee constructed for the purpose of controlling admission of Kern River flood waters to Buena Vista lake in the year 1888 by Henry Miller of Miller and Lux, and James B. Haggin, one of the founders of the Kern County Land Company. This levee bears the name of an early rancher who operated a ferry across the slough at this point.

Structure and Geology

The structure of the North Coles Levee oil field is that of an elongated dome with an almost east-west trend. The apex is situated in the northeast quarter of Section 32, Township 30 South, Range 25 East, M.D.B.&M. The field is about four miles long and one and three-fourths miles wide. Although there is no surface evidence of structure, folding is reflected in all beds below the Recent river fill. The discovery well was located after intensive work with the reflection seismograph in the early part of 1938.

Formations from the surface to 4000 ft consist of Recent, Tulare, and San Joaquin clay beds. This Quarternary-Upper Pliocene interval is predominantly sand down to about 1800 ft and largely shale with a few lenticular sand lenses from 1800 to 4000 ft. From 4000 ft to about 7000 ft, the formation is predominantly shale of Etchegoin-Pliocene age. There are a few lenticular sand bodies. Numerous normal faults are present in this interval. These faults seem to die out with depth and, with one or two minor exceptions, are unidentifiable below the base of the Etchegoin. In several areas these faults, combined with otherwise favorable structure and discontinuity of the sand bodies, have resulted in the entrapment of dry gas. These dry gas sands range in depth from 4000 to 5600 ft and have an aggregate areal extent of 400 acres. From 7000 ft to a little below 9000 ft, the formation consists of Upper Miocene beds of the Monterey series. The upper 800 to 1000 ft of Miocene consists of shale with no sand bodies of any significance. This shale becomes increasingly compact and indurated with depth, and is immediately underlain by an interval of about 200 ft of very hard, cherty, brown shale known as the "Chert Zone." Near the top of this zone is an outstanding electric log marker known as the "N" point. It is the most consistent and widely used point for contouring in deep producing areas of the central part of the San Joaquin Valley. Below the "Chert Zone" lies a sandy series that has a total thickness of about 1000 ft. A number of local names have been applied to this sand and to various subdivisions of it, but the whole interval is usually known as the "Stevens sand." Permeable sands in the North Coles Levee field first occur at points from 200 to 400 ft below the top of the "Chert zone."

Fig. 1 shows pictorially the sands that occur below the Chert Zone. The first permeable sands come in irregularly from 200 to 400 ft below the "N" point. In general, these sands tend to shale out on the top of the structure but include

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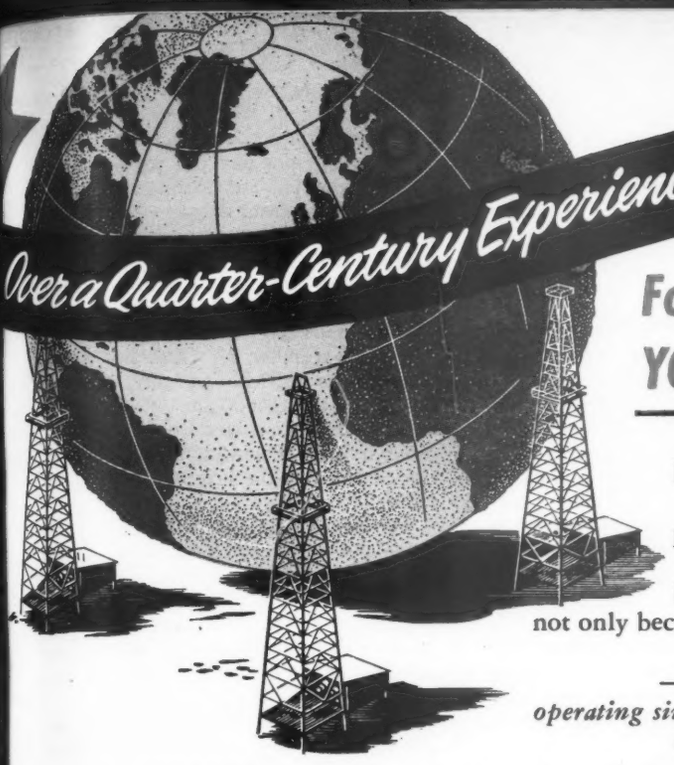

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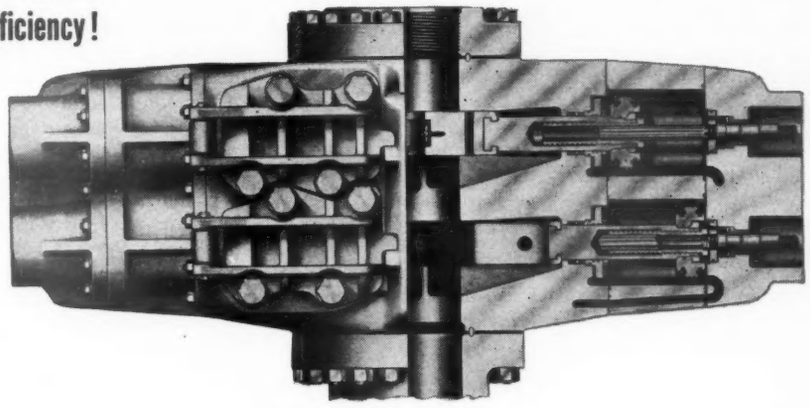

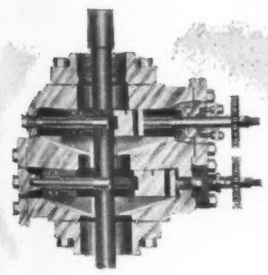

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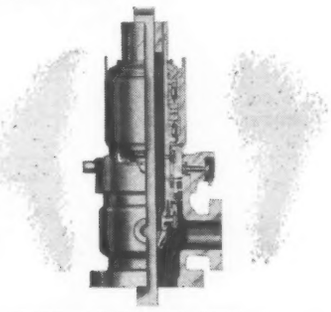

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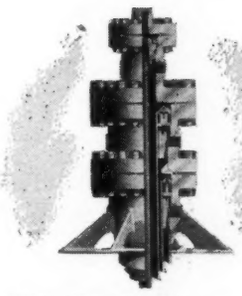

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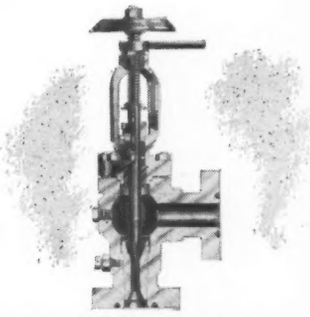

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some very good sand bodies on the flanks and on the eastern plunge. A development of this type on the south flank and eastern plunge of the structure is known as the "Upper Western zone." Another development on the north flank and eastern plunge of the structure is known as the "21-1" zone. Below these zones is a large, continuous sand body known as the "Lower Western zone." It consists predominantly of permeable sands with a few relatively thin and apparently discontinuous shale bodies. These shale bodies are of very little value in correlation, and are apparently so limited in areal extent that they have only a minor influence upon the movement of reservoir fluids. About 300 acres on the crest of the structure were originally occupied by gas cap. There is no faulting of magnitude sufficient to be discernible from electric log correlations or from cores below the top of the Chert zone. Behavior of the reservoir in regard to pressure, productivity index, and gas-oil ratio suggests that a permeability barrier of some type, trending North 60 deg East, exists across the south portion of Section 29, Township 30 South, Range 25 East. A permeability barrier is assumed since cores and electric log correlations reveal no evidence of faulting.

The Upper Western zone in some portions of the field is pressure connected through bore holes with the Lower Western Zone. For this reason they generally have been considered as one pool, the "Main Western."

The "21-1" zone shales out near the top of the structure and is definitely separate from the other producing zones.

The area to the northwest of the permeability barrier in Section 29 is known as the "Western 29 Pool" and is considered separate from the Main Western pool.

Fig. 2 is a contour map on the "N" point and shows the delineation of the three pools.

Reservoir Characteristics

The Stevens sand, which is the formation occurring in all pools in North Coles Levee, is considered typical of central San Joaquin Valley Miocene. The sands are poorly sorted and contain rather large amounts of silts and clays. Sand permeabilities in all pools vary over the wide range of zero to 7500 millidarcies. Average permeability in the Main Western pool is approximately 115 millidarcies.

Analysis of numerous cores indicates the average porosity is approximately 20 per cent. No reliable interstitial water determinations are available, but it is believed to follow the California average for like permeabilities.

Produced oil gravities vary considerably, ranging from 32 to 45 API. Extraneous conditions, such as trapping pressure and temperature, as well as gas-oil ratio, affect the observed gravities. It would seem reasonable in a black oil zone of thickness in excess of 500 ft to have a gravitational segregation of fluid, but very little has been observed.

Average reservoir temperature at the 8500-ft subsea datum is 230 F.

Initial reservoir pressure at the 8500-ft subsea datum was 3990 psia.

Pressure-volume-temperature determinations gave a bubble point pressure of 2550 psia, with a gas-oil ratio of 600 cu ft per barrel.

Initial productivity indices ranged from 0.4 bbl per day per psi to 2.3 bbl per day per psi and averaged approximately 1.2. Current average index is 0.7.

Development History

Discovery well of the field was Richfield Oil Corporation's Coles Levee "A" 32-32, completed in the Main Western pool on November 27, 1938. Initial production was 3018 bbl per day, 49.7 deg, 18,000,000 cu ft, 6000 gas-oil ratio. Later development disclosed that the perforated interval from 8406 to 8677 ft included 160 ft of the original gas cap and 111 ft of the black oil zone.

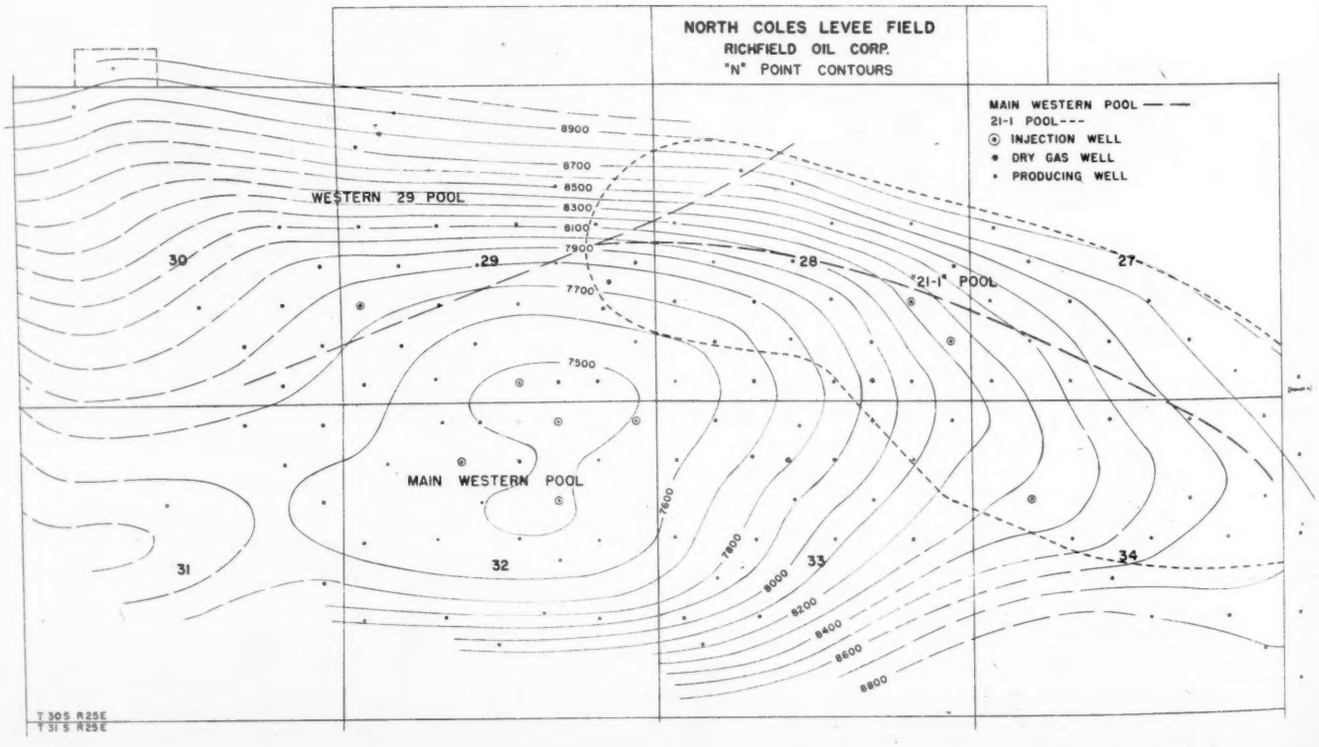
The third well in the field, Coles Levee "A" 12-33, located the gas-oil interface and the oil-water contact by continuous coring. The gas-oil interface was picked at 8255 ft subsea and the oil-water contact at 8840 ft subsea, indicating 585 ft of black oil zone at this location.

After the above information was obtained from well 12-33 in November 1939, a rapid development program was instituted. A total of 69 wells was completed by the end of 1941. Since that time development has proceeded at a slower rate. As of June 30, 1951, total development was as follows:

	Pools				
	Main Western	Western 29	"21-1"	"68-29"	Field Total
Producing....	87	16	20	2	125
Producing and injection....	1	0	0	0	1
Injection.....	4	1	2*	0	7*
Shut-in.....	0	0	7	0	7
	92	17	27*	2	138

* Includes two combination wells that inject into "21-1" pool and produce from Main Western pool.

FIG. 2.



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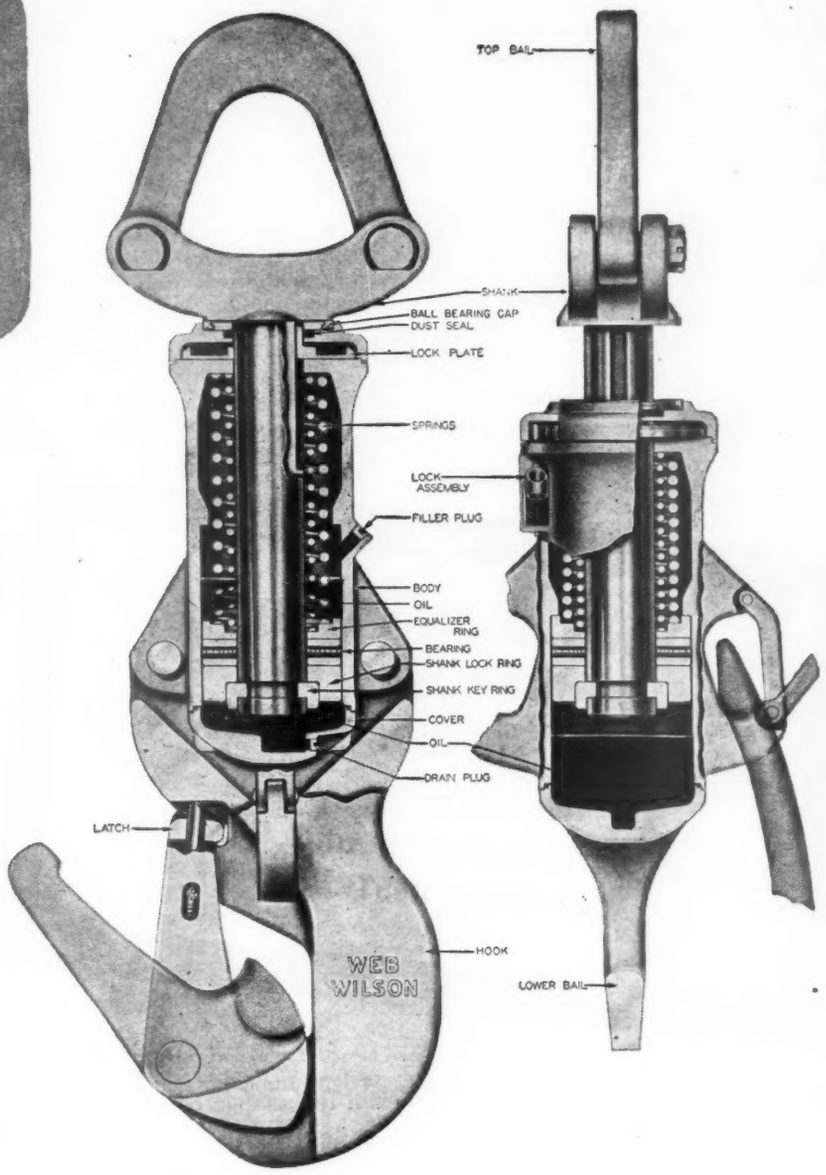

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No unusual difficulties have been encountered in development of the field. Experience gained in drilling and the use of improved equipment have resulted in a reduction of the drilling time required from an average of 75 days in 1940 to 45 days in 1951. Drilling through the Chert zone consumes about one-third of the total time.

The casing program has consisted of a surface string of 11¾ or 13⅜ in. casing cemented at 1400 ft, a water string of 8⅝ or 7 in. casing cemented at the top of the sand at depths ranging from 8300 to 9100 ft, and a 6⅝ in. or 5½ in. liner cemented through perforations from below the gas-oil contact to the water string.

The numerous wells drilled to date to the oil-water contact indicate a tilted water table. In general, water occurs at higher elevations in the saddle at the western end of the field and on the south flank. The water table slopes in a downward direction toward the eastern end of the field and on the north flank. It is believed that the tilted aspect of the water table is primarily caused by changes in permeability, the high water table, and the very low permeability effecting closure in the west end of the field. The phenomenon of a tilted water table is not unusual in California, occurring in the South Coles Levee and the Paloma fields immediately to the south. There has been no apparent movement of the water table since discovery, and an expanding gas-cap mechanism is assumed under normal operation.

At the present time about 25 undrilled locations remain at North Coles Levee.

Production History

The production history of the field has followed an orderly and planned pattern. This has been possible because the operation has been a unitized one from inception. One operator, Richfield Oil Corporation, holds substantially all the productive acreage in the field, all but 20 acres of which is under lease from the Kern County Land Company. As California has no law regulating production of oil and gas or requiring unitization of pools, many fields of this type have had disastrous production histories resulting in economic losses and waste of reservoir energy when several operators were involved. If North Coles Levee had been developed and produced under competitive conditions, the field would have probably been over drilled and no effective control of oil production or gas production would have been possible. Under these conditions, the pool would necessarily have been produced under an expanding gas-cap mechanism with no return of produced gas to the reservoir. From the performance of similar pools under these conditions, we are confident that the ultimate recovery at North Coles Levee under like circumstances would not have greatly exceeded 100 bbl per acre foot. Under unit operations we are now sure that ultimate recovery will be twice this figure, and it may be substantially more. Up to the present time, over 94 billion cubic feet of gas have been produced and, with the addition of make-up gas to replace the volume of oil extracted, cumulative injection totals 102 billion cubic feet. If this gas had been sold as it was produced, the price obtained from it would have varied from four to 14 cents per thousand cubic feet. It is worth substantially more than that at this time, and it appears probable from present plans that when finally sold the gas will command several times the present price. This increase in the value of the gas will approximately offset the total drilling, producing, and pressure maintenance costs incurred up to the present time. Cumulative figures for the Main Western pool at August 1, 1951, are as follows:

Oil produced	48,456,450 barrel
Gas produced	94,204,730 Mcf
Gas injected	102,004,612 Mcf
Water produced	1,144,092 barrel
Gas-oil ratio	1944

After the gas-oil interface was located at 8255 ft subsea, subsequent wells were cemented through perforations below this point with uniformly low gas-oil ratios of 600 to 800 cu ft per barrel.

During the first four years the field was produced under the influence of gas-cap expansion. Reservoir pressure of individual wells was closely observed, and production rates were allotted to wells in such a manner as to prevent any pres-

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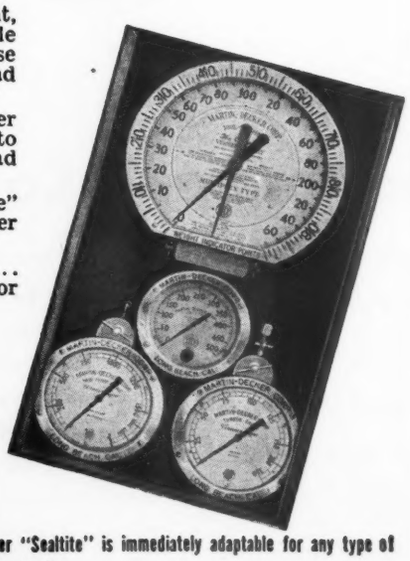

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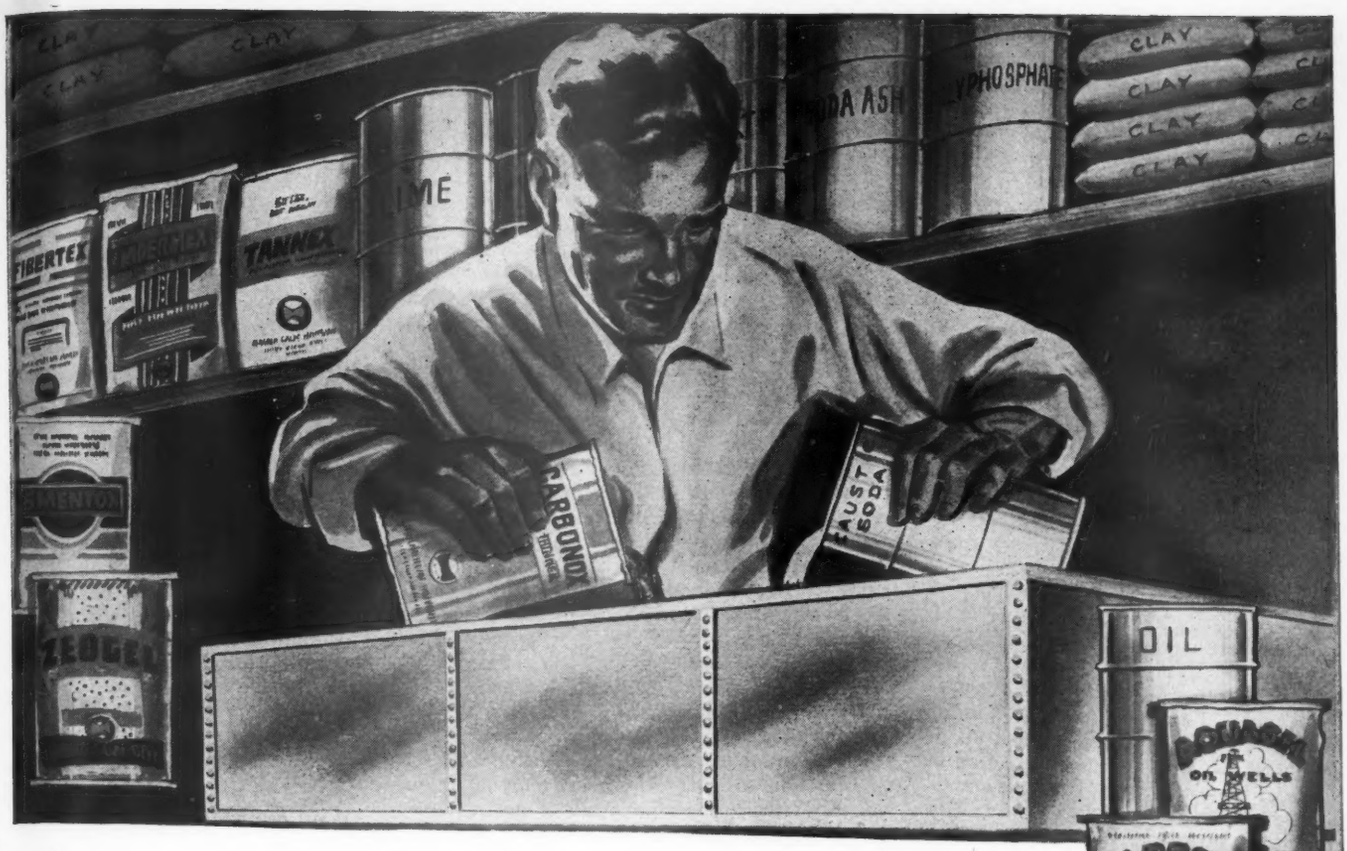

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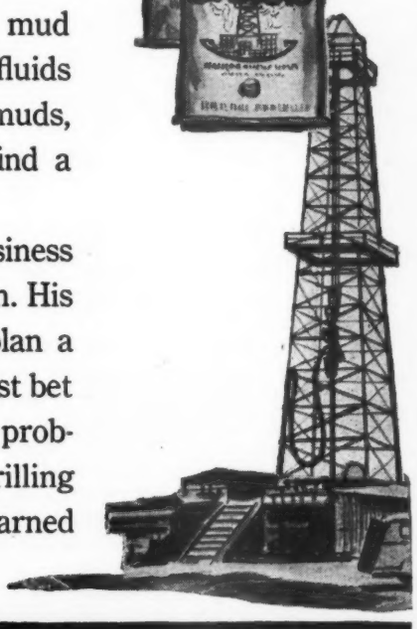

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sure sinks in the black oil belt that would promote coning of the gas cap. During this four-year period, the pool pressure showed a normal decline with no apparent edge water movement. Wells that were completed initially in the gas cap were shut in to conserve reservoir energy.

While the pool was being exploited in the conventional manner, an intensive study was undertaken to determine the best means of exploiting this deep, relatively low permeability reservoir. The possibility of injecting residue dry gas was investigated. Previous experience in California was confined to pools in which gas was injected after substantial depletion and pressure drop had taken place, due to the difficulty of controlling production rates while unitization agreements were being consummated. The results of gas injection in relatively undepleted fields in the Gulf Coast area indicated the economics of such a program were attractive.

Plans were made to inject residue dry gas into the Main Western pool, and it is this operation with which this article is primarily concerned. Although gas injection is currently being carried on in all pools, the Main Western injection is the most important, both from the standpoint of gas returned and also as regards cumulative oil production.

It was decided not only to return all the residue dry gas produced but to completely balance reservoir withdrawals by means of make-up gas. A 3600 hp injection plant was completed and the first gas injected on November 19, 1942. At this time the Main Western reservoir pressure had declined from an initial of 3990 psia to 3370 psia. Pressure-volume-temperature relations indicated the bubble point of the reservoir fluid was approximately 2550 psia. By January, 1943, a complete volumetric balance was attained, and has been maintained since that time. The dry gas zones in the Etchegoin formation have been developed as a source of make-up gas. In addition, other sources of make-up gas, primarily under company control, have been drawn upon.

The initial compressor plant was adequate to inject gas at rates varying from 20 to 35,000,000 cu ft per day at pressures ranging from 3200 to 3400 psia.

By the summer of 1947, additional injection capacity was required, not only for the Main Western pool but also because reservoir pressures in the other pools had by now declined to a point approaching solution pressure. It was felt that pressure maintenance efforts in the other pools should be undertaken as soon as possible. This addition to the compressor plant brought total injection capacity up to 53,000,000 cu ft per day.

Expansion of the gas cap has followed a rather uniform downward pattern. In almost nine years of gas injection the gas-oil interface has expanded from the 8255-ft subsea initial depth to approximately 8500 ft subsea as shown on Fig. 1. This expansion has necessitated remedial measures to control gas-oil ratios, which will be covered in a later section. Suffice it to say here that, while initially remedial measures were undertaken when gas-oil ratios approached 5000 cu ft per barrel, recent practice has been to produce a well to as high a ratio possible within injection plant capacity in order to insure complete sweeping of the invaded interval before remedial steps are undertaken.

From inception the pool has operated under strict production control. Production has been allocated to individual wells by a formula that takes into account productivity index, reservoir pressure, formation volume factor, and, when the pool was not fully developed, an acreage factor.

Pressure maintenance operations were undertaken when the reservoir pressure exceeded solution pressure by approximately 820 psi. This differential has been maintained. In addition, no well under producing conditions is permitted to have a draw-down that exceeds the solution pressure. By this means the relative permeability of the sand to gas is kept at a minimum, and oil permeability is kept at a maximum. This, as much as any other factor, is believed to be the reason for the success of the project.

Injection is currently being carried on through five injection wells. Four of these are gas injection wells only. The fifth is a combination injecting-producing well, isolation between the injection and producing zone being accomplished by a cemented blank section and a tubing packer.

Early in the life of the field the injection interval in one well extended well into the black oil zone. This was recognized as a mistake, and the interval was shortened to include only the gas-cap interval. All injection wells are currently injecting primarily into the original gas cap, with maximum penetration of one well into the black oil zone of approximately 100 ft. This limiting of injection to the original gas cap is also believed to be an important reason for the success of the project. By this means the operation has been maintained as a gravitational segregation project rather than one of gas drive.

In August, 1951, a further addition to the injection plant was made, bringing total capacity up to approximately 73,000,000 cu ft per day. This additional injection volume will be used primarily for the other pools, although injection rates in the Main Western pool will be increased to a little more than a complete volumetric balance.

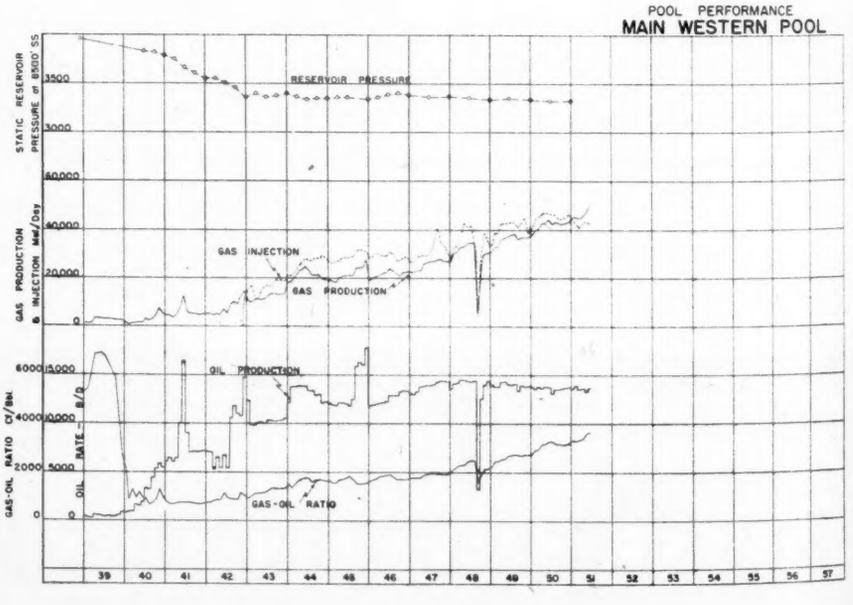
Fig. 3 is a performance curve of the Main Western pool. It should be noted that the volume of gas produced and the resultant gas-oil ratio depend to a great extent on the frequency of remedial work. Every effort is made to keep the produced gas volume as low as possible through production control, but actual remedial measures are taken only when near maximum injection is insufficient to balance withdrawals. This permits scheduling of three to five workover jobs in succession for a remedial crew.

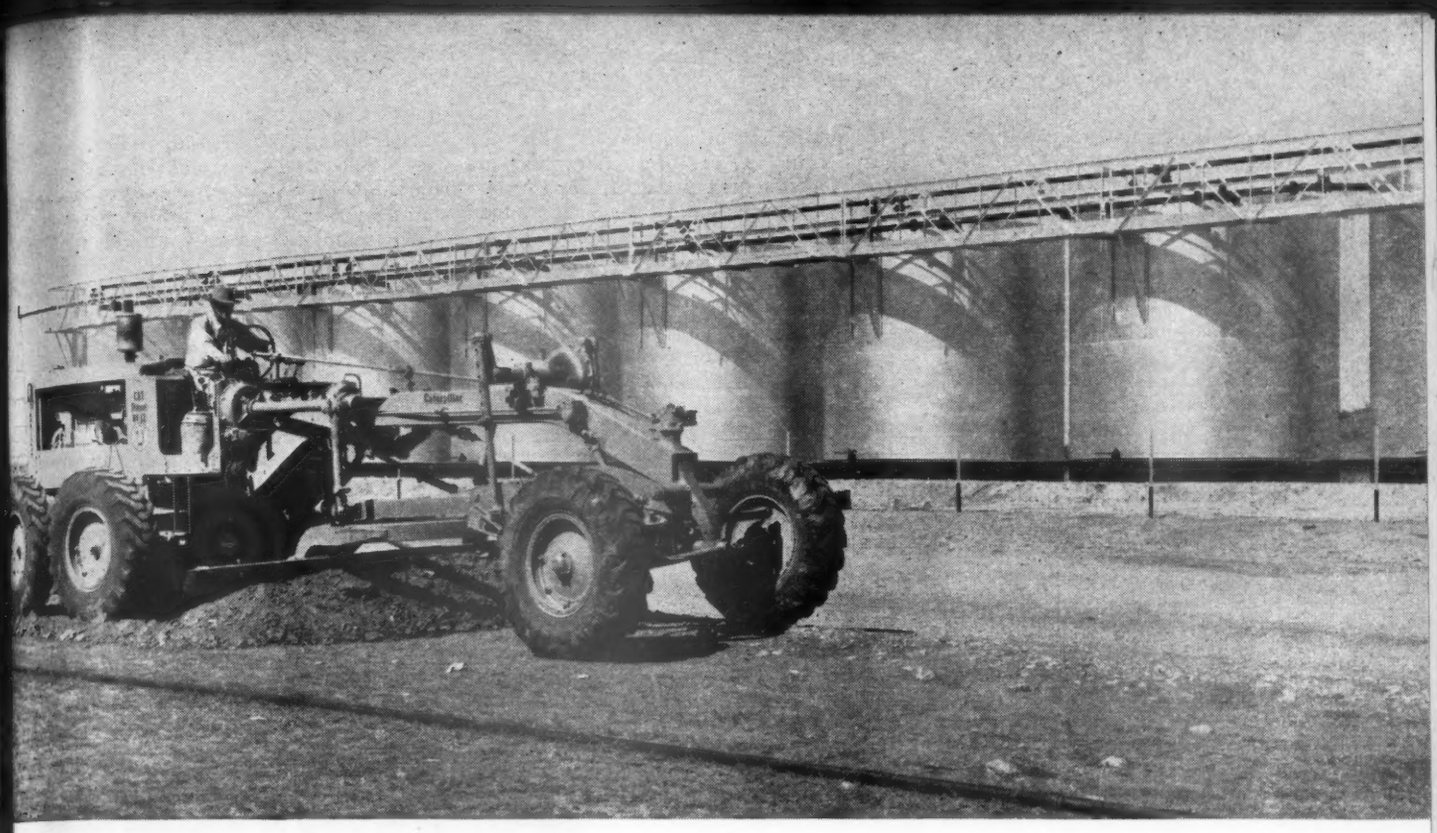
Gas-Oil Ratio Control

It was realized from the start of gas injection that effective gas-oil ratio control would be a problem that would require solution if the project was to be a success. The initial wells completed high on the structure were converted to injection or shut in until remedial work could be undertaken.

Free gas first appeared in wells completed below the original gas-oil interface in February 1941. By April 1942, six wells were shut in because of high

FIG. 3.





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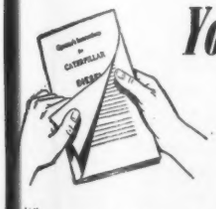

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ratio. It was obvious that remedial measures were necessary, not only to return the wells to producing status but also to eliminate the danger of secondary injection through the shut-in wells.

Temperature surveys during casing flow were made upon the affected wells to pick up the cooling anomalies evidenced by expansion of free gas into the well bore.

After the gas entry points were determined from temperature surveys, remedial measures were undertaken. When the original liners were run, 40-ft blank sections were provided opposite shale bodies at one or two points in the hole. These were provided with the thought that they might be cemented at a later date for gas-oil ratio control. Early in 1943 a program was instituted to follow this plan, and eight high ratio wells were repaired in this manner.

As might be supposed, eventually gas entries occurred where blank sections were not provided in the proper intervals for gas exclusion. In four cases of this type, the old liners were pulled and new liners were run equipped for cementing at the desired points. The excessive cost involved in this operation made it imperative that a cheaper method of gas-oil ratio control be found if the injection program was to be an economic success.

A method was developed that made it possible to cement a blank sleeve inside a perforated liner for approximately the same cost involved in the early program of cementing blank sections. The method consisted of washing with a rather viscous bentonitic mud opposite the interval to be cemented with a specially designed tool. The upper part of the tool has a by-pass collar at the point of equalization of the cement. The collar permits the use of rubber plugs in front of and behind the cement to prevent contamination. It has been found that contamination effects are very important where small quantities of cement are used. The lower part of the tool consists of a tubing mandrel with opposed swabs. This tool is shown in Fig. 4. After washing with mud the tool is lowered to 10 ft below the bottom of the intervals to be cemented, and the mud is replaced with water above this point. Cement is then pumped in the tubing. When the cement starts out the liner perforations, the tool is slowly raised over the interval to be cemented so that the tool arrives at the top of the interval when the cement reaches the point of equalization. No further circulating is done and the cementing tool is removed from the hole.

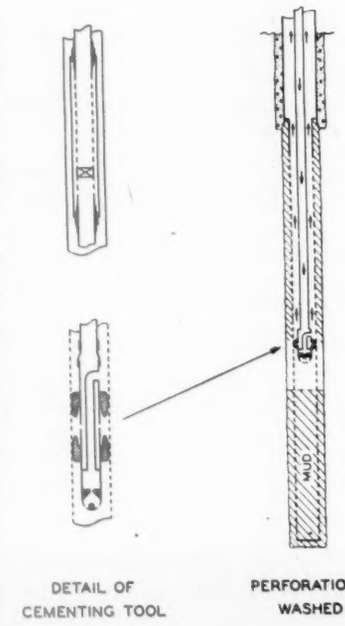
After the cement has set, a bit is run in and the water displaced with mud. The cement is drilled out and the liner scraped to a point ten feet above the bottom of the bridge. A close fitting sleeve is then run, landed on the cement bridge, and cemented through tubing with a thin slurry. In 6⅝ in. liners a 5½ in. OD Grade "A" steel sleeve is used. It has been found that the soft Grade "A" steel will mill readily if necessary. After a differential test across the sleeve, the hole is cleaned out to bottom and tubing is run equipped with a hook-wall packer which is set in the blank section. The packer and cemented sleeve are tested by applying pressure to the casing annulus. The well is then swabbed in. Seventeen remedial jobs have been successfully performed in this manner. Fig. 5 shows details of the cementing operation.

Beginning in February 1944, two events occurred that made it no longer possible to obtain temperature anomalies by means of casing flow. All wells were completed initially without tubing packers. On February 3, 1944, well Coles Levee "A" 61-33 developed a leak in the 8⅝-in. casing. The pressure dropped to zero on the tubing and built up to 1600 lb between the 8⅝-in. and 13⅜-in. casings. This pressure on the 13⅜-in. casing caused a leak to develop through a faulty weld at approximately 50 ft. After this occurred, gas and oil started flowing out of the ground at several points in a 100-foot radius around the well. The pressure developed on the 22-in. conductor pipe caused the entire concrete well cellar and mat to be raised and turned to one side. This movement caused the landing slips on the 8⅝-in. casing to be pulled out, and the pipe was necked down to 8 in. but remained intact. The entire area around the well cellar cratered and the well flowed about 4000 bbl per day around the casing landing head. A high line was rigged across the area and an employee rode a cart on the line to the tubing head and connected a cementing hose. The well was finally killed with water and was subsequently plugged with cement and abandoned.

In April 1944, well Coles Levee "A" 36-32 dropped sharply in production. Bottom-hole pressure conditions appeared normal but a temperature survey indicated a leak in the 8⅝-in. casing at 1500 to 1600 ft. The well was killed with mud and a full string of 6⅝-in. casing was run in the 8⅝-in. casing. This well was returned to production.

Due to the relatively large flow of oil

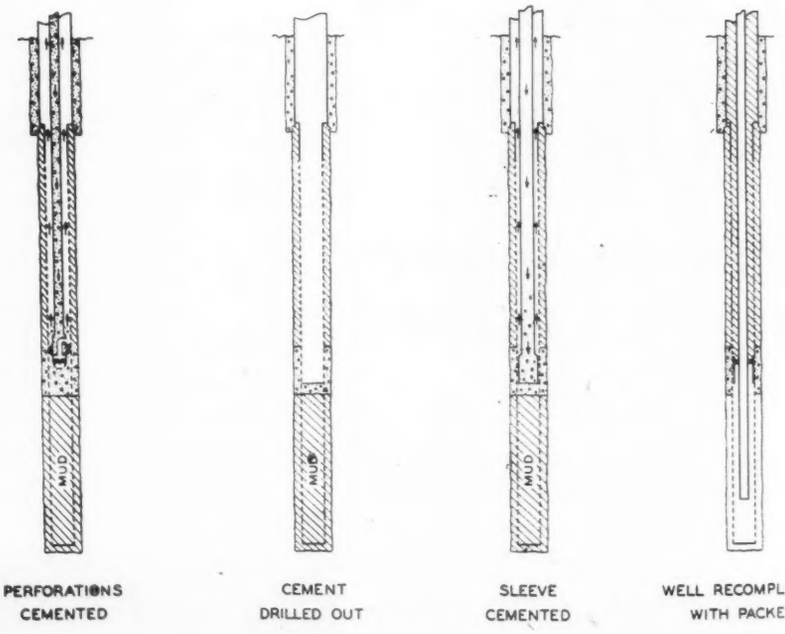
FIG. 4.



DETAIL OF CEMENTING TOOL

PERFORATIONS WASHED

FIG. 5.



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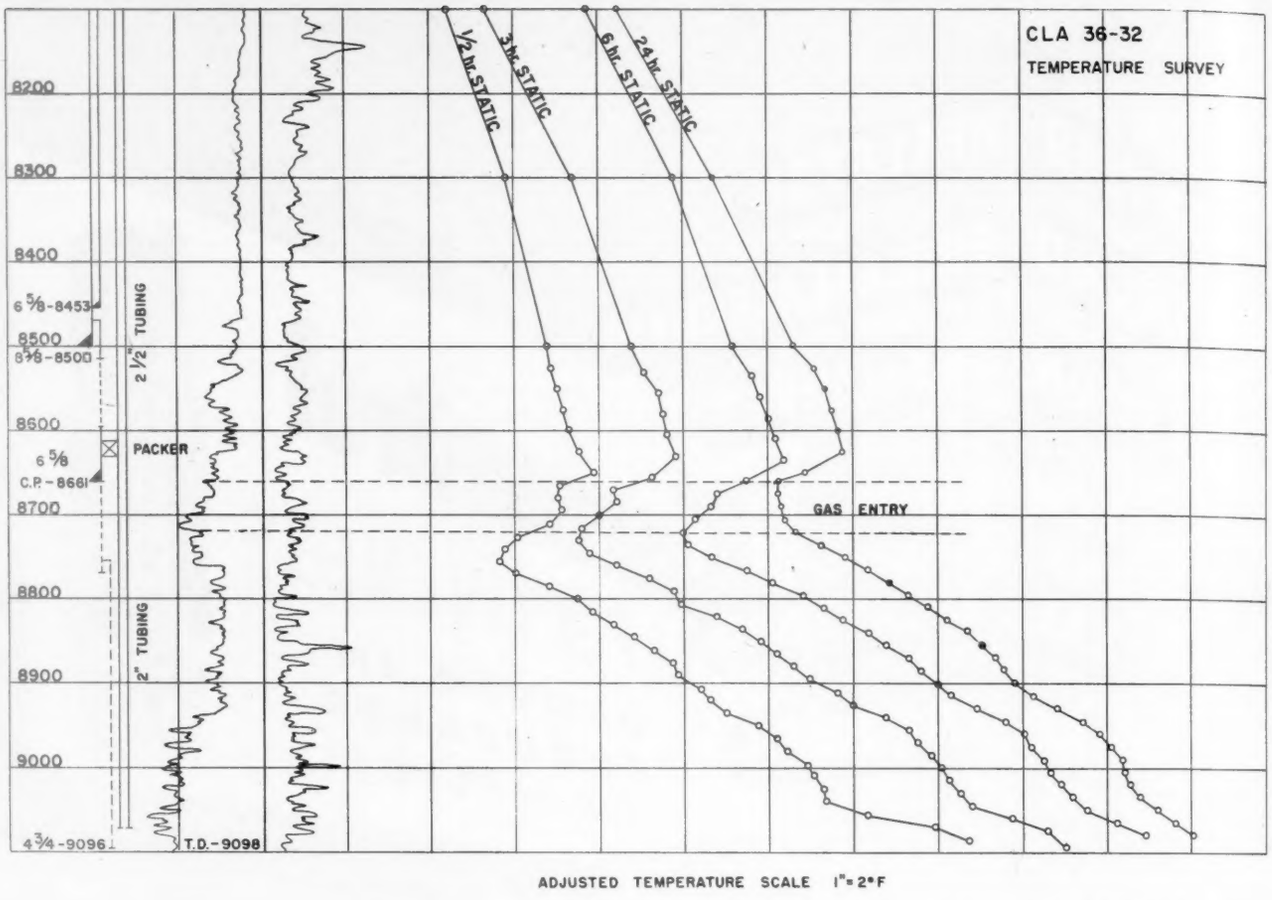

FIG. 6.

and gas out of the casing at the 1500 to 1600-ft interval, a relief well, Coles Levee "A" 136-32, was drilled to this depth to aid in killing well 36-32.

To prevent further occurrences of this nature, future wells were cased with 7 in. casing and a program was immediately instituted to equip all producing wells with tubing packers with a gel mud in the annulus above the packer. A system of periodic checks was inaugurated to detect any casing pressure build-up that would be indicative of a packer failure. No difficulties have been encountered since the packer installations.

These packer installations, and the fact that the wells were tubed very close to bottom to assist in gas-oil ratio control, made it necessary to find other means of obtaining the information on temperature anomalies that had previously been available on casing flow. One possibility, of course, would involve killing the well and either removing the tubing tail below the packer or removing the packer to allow casing flow. Neither of these was desirable because temperature surveys are made frequently, not only for remedial work but also to secure data regarding gas-cap expansion. It was desired to continue these periodic surveys without altering the condition of the wells in any way.

A method of obtaining these necessary data with tubing flow was evolved by the late E. A. Gray, Richfield Oil Corporation. The problem was difficult because the counterflow of oil and free gas down the annulus to the bottom of the tubing appeared to effectively mask any temperature anomalies that could be recorded inside the tubing. Unlike casing flow, it was found that a tubing flow survey was of practically no value. It was found, however, that good anomalies were obtained on successive static surveys following a high flowing rate. Due to the movement of the cool gas in a downward direction during flow, the first static after one-half hour usually indicated a lower entry than was actually occurring. Successive statics at short intervals after this usually show a progressive movement of the bottom entry point up the hole, until, opposite the true entry point, the apparent movement ceases. These anomalies usually vanish after about 24 hours.

Fig. 6 shows a temperature survey with tubing flow. It will be noted that stops are made at 15-ft intervals in the gas entry area. The temperatures recorded are read to the nearest 0.05 F. This does not mean that the actual temperature is that value at any point, as the temperature elements are not calibrated for long periods of time. The values do mean, however, that there is a certain temperature difference between any two points on the plot, and it is from these differences that the required temperature anomalies are obtained. The equipment used is a standard Amerada recorder and 300 F temperature element.

Summary and Conclusions

With a background of almost nine years' history, the following are believed to be primary reasons for the successful gas injection program in the Main Western pool:

1. Early injection before the pool pressure had declined below the bubble point.
2. Close production control possible under a single operator and a single landowner.
3. Operation of all wells under producing conditions at bottom-hole pressures above the bubble point.
4. Gas injection only in the original gas cap.
5. Productivity indices high enough to permit moderate pool production rates with relatively small drawdown.
6. An effective program of gas-oil ratio control at moderate expense.
7. Availability of additional gas to allow complete replacement of produced volumes.
8. A reservoir of rather large closure uncomplicated by faulting.

It is apparent that many of the above conditions are distinctly unusual, and it is rare indeed when one reservoir has all these conditions. Lacking effective state control over production, however, it was only the fortuitous combination of a single operator and a single landowner that made possible the effective utilization of all the features in a successful pressure maintenance project.

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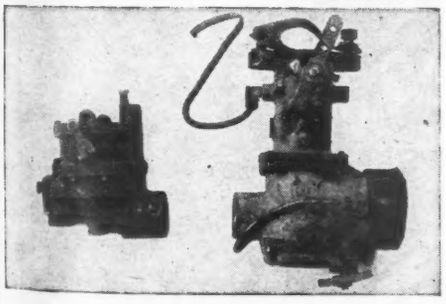

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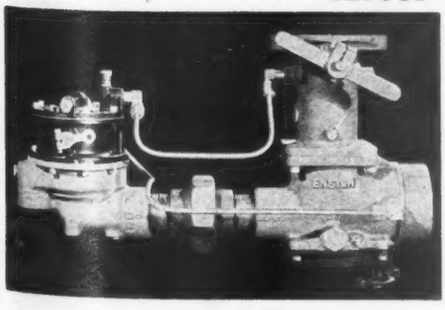

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The Role of Workovers in Coastal Texas and Louisiana

SIDNEY A. JUDSON

THE importance of workovers in developing production in the most economical manner can hardly be overemphasized, and has been increasingly brought to the attention of coastal operators in the past several years by the experience record of savings obtained. The large number of multiple sand fields, the increasing depth of wells, the scarcity of steel, and the technical improvements in directional drilling and in gun perforating casing have all been factors in influencing operators to avoid costly new wells where possible and use less expensive workovers instead.

The scope of this paper is too general to include the details of the many and varied methods of workovers. These are already ably described by many writers in various technical and trade journals. The general methods outlined below, although mostly those of one company in a particular field, nevertheless are generally typical of those in use throughout most of coastal Texas and Louisiana. The various procedures are modified or supplemented in each field by the ingenuity of the operator to meet the conditions found.

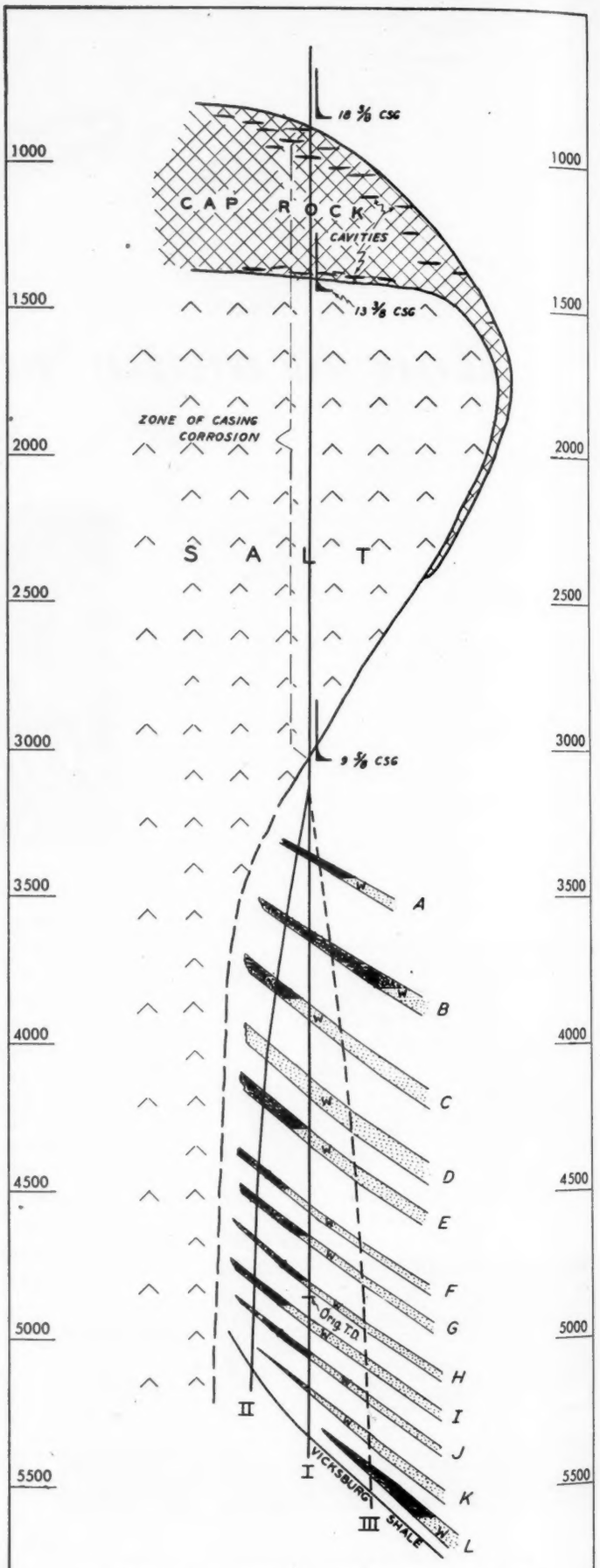
The term "workover" is used in this article in its broader sense; namely, to include any operation to establish production by using again all or part of a previous hole; that is, its meaning is not limited to remedial work alone, but even includes development of additional pays, often in a sidetracked hole.

The workover methods in use in the coastal fields resulted from trying out each likely method as it appeared in the industry, and then selecting those that gave the desired results. Although improvements are still being made, the methods now in use get the job done. This is true with one notable exception; namely, effectively preventing excessive quantities of sand from being produced with the fluid and thereby causing wells to "sand up." This remains a challenge to the ingenuity of the industry.

The operations at Barbers Hill, Chambers County, Texas, have been selected to illustrate the methods used, since the field has a long and varied program of workovers and because of the writer's familiarity with their history, particularly those of the Texas Gulf Producing Company. This field is a piercement type salt dome producing oil from multiple steeply tilted unconsolidated sands principally beneath overhanging salt. Many radial faults divide these multiple sands into separate reservoirs. Operations here for the past 15 years have been largely confined to workovers except for occasional new wells drilled generally outside or above the salt.

Workovers here are divided into five general classes:

1. Repairs to well equipment where no change is made in the producing interval. (a) Installation or repairs to screen settings either in open hole or opposite perforations in the casing. (b) Repairing or replacing damaged casing.
2. Deepening to lower pays.
3. Plugging back to higher pays.



CROSS SECTION SHOWING FLANK OF OVERHANGING SALT DOME

FIG. 1.

EXCLUSIVE

4. Sidetracking directionally to reach sands in a more favorable structural up dip position, or in another fault segment.

5. Sidetracking directionally away from the dome to produce a sand that is present only farther out from the dome.

Replacing screen or slotted pipe is made necessary by the damage caused by the cutting action of loose sand held in suspension in the fluid being produced, or when the openings in the screen or slotted pipe become clogged, which occurs mostly at low rates of production. This is the most frequent and fortunately usually the least costly type of workover.

The portion of the casing opposite the salt and the cavernous cap rock is subjected to strong corrosive action and in time will fail. This part of the casing when seriously damaged is pulled as deep as possible and replaced. The life of this portion of the casing varies considerably, but an average period is about 10 years. This operation is usually combined with drilling a new directional hole below the salt as the lower part of the hole is usually lost.

Wells are deepened when necessary. Some wells originally were "bottomed" before drilling through all the multiple sands of Miocene and Oligocene age and are deepened later. This requires removal of the liner and the screen or slotted pipe. The well is then deepened vertically or directionally, and a liner is set into the deepest favorable sand, which is produced through gun perforations, with or without an inside screen as conditions and the judgment of the operator determine. A deepening operation is shown in Well No. 1 in Fig. 1. After producing sand "H" the well was deepened to explore sands "I," "J," and "K."

A hole is usually first produced from its lowest oil sand and as it is depleted, is plugged back to the next higher one. The depleted sand is first cement squeezed, and if necessary the sand to be produced is isolated by squeeze jobs above and below it. The casing is then gun-perforated and inside screen or slotted pipe is set if desired. This operation is frequently the most profitable of any of the workover operations. This program continues until all the higher sands are depleted one by one, or until it becomes necessary to sidetrack the well because of mechanical reasons. Previous to the introduction of gun perforating, the production of higher sands required a new hole to be whipstocked out through the casing and a screen and liner set in the sand. The present method of plugging back to higher sands by gun perforating has greatly reduced the cost below that of the former method.

Most wells are directionally sidetracked when all the sands in a hole are depleted or the casing through the cap rock and salt requires replacement. The position usually sought for the new hole is one closer to the dome to produce the up dip ends of sands that lie above the oil water contact existing at the time the former hole is abandoned. Fig. 1 shows a diagrammatic cross section of multiple sands and their oil water contacts at the time the original hole 1 is ready to be sidetracked. It will be noted that this hole had been originally bottomed through sand "H" and that sands "H," "G," and "E" had been produced from it as indicated by the oil water contacts at the approximate position of the well. The sands "B" and "A" were not produced in hole 1 presumably because of the mechanical condition. The hole was then directionally drilled closer to the dome into position 2 to produce the remaining up dip oil in sands "J," "H," "G," and "E" as well as testing and producing additional reservoirs in "I," "F," "C," "B," and "A." The directional hole in position 2 can be redrilled if the casing opposite the salt or cap rock fails before all the reservoirs are drained. In this operation the oil string is usually removed to a point slightly below the bottom of the casing set through the salt. This salt string is usually 9⅝ in. OD, which allows a hole sufficiently large to be drilled to permit a more efficient control in deviating the hole than a smaller one would allow. It is to be particularly noted that the deviation shown begins below the salt, although a few wells have been deviated in it, but difficulty of control is usually experienced in that formation. The angles used seldom exceed 10 or 12 deg from the vertical, and the rate of change of deviation is gradual to minimize difficulty in setting casing or in pumping. It is also to be observed that the bottom part of hole 2 is nearly vertical to avoid drilling into the salt wall.

The planned objectives are required to be reached with a considerable approach to precision. The tolerance in or out from the objective is usually about 10 or 15 ft, while a somewhat greater amount is allowed along strike. In more gentle dipping fields a much greater latitude would be granted. The comparative ease with which directional objectives are now reached is due to the improved directional drilling tools, mud control, and added experience in this type of drilling.

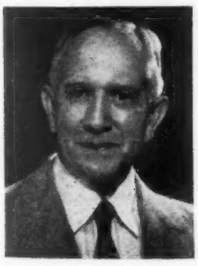
Fig. 1 shows hole No. 3 deviated away from the dome to reach sand "L," which pinches out toward the salt. A workover of this type is usually of an exploratory nature.

As usually the greater part of the cost of drilling a well is spent by the time casing is set just beneath overhanging salt, the use of workovers below the salt is a boon to the general operation here, both in exploration for new reservoirs and in the development of known ones. The cost of a major directional workover is estimated to be about one-half to one-third that of a new well.

It is evident that the saving of materials and drilling costs allows otherwise non-commercial reservoirs to be profitably tested and developed, or the up dip ends of partly depleted reservoirs to be produced. It is believed that if workovers had not been utilized at Barbers Hill, millions of barrels of oil would be left in the ground that will now be produced. Similarly in most of the coastal fields of Texas and Louisiana material amounts of otherwise unrecoverable oil can be discovered and produced through the medium of workovers. The aggregate saving in steel requirements alone is of prime importance in time of either a hot or a cold war.

Therefore, before beginning to drill a new well in an established field an operator should always answer the question, "Will a workover of an existing well serve the purpose?" ★ ★ ★

The Author



Sidney A. Judson was graduated from Syracuse University in 1912 with a degree of civil engineering. After five years in the topographic branch of the U.S. Geological Survey, in 1917 he entered the employ of F. Julius Fohs, consulting geologist, in Tulsa, Oklahoma. In World War I he was Captain and Regimental Adjutant with the 25th Regiment of Engineers, AEF France. Since then he has engaged in exploration and production geology with the Humphreys Corporation and later with the Texas Gulf Producing Company in the southern mid-continent region. Beginning with 1925 he has specialized in exploration and production studies of the Gulf Coast of Texas and Louisiana.

On Judson's recommendation a well was drilled in 1929 through the salt overhang at Barbers Hill, Chambers County, Texas, to find large production beneath salt for the first time. He has pursued detailed studies of this dome up to the present, and is the joint author of several articles of the geology and methods of operation of this field.

From 1935 to 1942 he was president of the Justa Petroleum Corporation. He is now production geologist with the Texas Gulf Producing Co., Houston.

Imports Off

For the four weeks ended September 15 total imports of crude oil and petroleum products averaged 679,800 bbl a day, comprised of 451,600 bbl of crude oil, 210,900 of residual fuel oil, 6000 of asphalt and 11,300 of other petroleum products.

The American Petroleum Institute reported that imports in the last week of the report had dropped 133,500 bbl to 601,700, the lowest level in more than a year.

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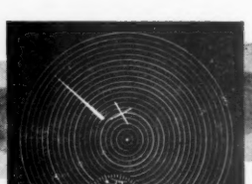

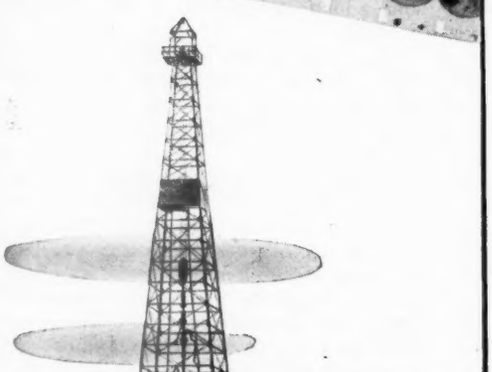

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Trucks and Cars in Oil Industry Increase

Accident rate has been held down and recently decreased despite expanded use of motor vehicles in all departments

In its nineteenth "Summary of Motor-Vehicle Accidents in the Petroleum Industry" the American Petroleum Institute presents data from 214 companies, which operate 77,197 motor vehicles during the year. Not all the companies maintain complete mileage records. Of the 158 that do, it was calculated that accident frequency was 1.25 per 100,000 miles traveled. In other words, the 161,950 vehicles operated by the companies during 1950 traveled 980,993,347 miles and showed an average of one accident in 79,861 miles of travel.

One of the interesting things about the accompanying table is the increase in the use of motor vehicle in the operating departments of the petroleum industry. In refining, for instance, the increase has been steady since 1942. Production operations have also seen expanded use of trucks. It is the pipeline industry, however, that shows the most startling increase. Use of cars has more than doubled in 10 years and use of trucks has more than tripled in 10 years. This gives an indication of the rapid growth of pipeline operations.

In the part of the table under "All Departments," two classifications, division of marketing and miscellaneous, are included in the figures but are not given separately.

There has not been very great change in the number of accidents for 100,000 vehicle miles in the last 10 years. The definition of a motor vehicle accident is: "A reportable motor-vehicle accident is an accident in which a motor vehicle in company service is involved, unless properly parked, resulting in a death, personal injury, or property damage regardless of who was hurt, what property was damaged, or who was responsible." This is the same definition used by the National Safety Council.

In "All Departments" the percentage of accidents fluctuates but not in a regular curve. This is also true of Refining.

The production department of the industry shows a decrease in 1950 for the last 5 years and Pipe Line department accidents are lowest for 6 years.

There were 56 companies that could not report on the number of miles traveled but they gave their accident experience on the number per vehicle.

Including these, 214 companies reported 77,197 cars and trucks operated in 1950 and 14,577 accidents or 18.9 per 100 vehicles.

TABLE 1. Petroleum industry—motor-vehicle accidents per 100,000 vehicle miles

10-year comparison—comparison by departments, 1941-1950 (inclusive).

Year	No. of companies	Passenger cars reported separately: No. of cars	Passenger cars: No. of vehicle miles traveled (thousands)	Passenger cars: No. of accidents	Passenger cars: No. of accidents per 100,000 vehicle miles	Trucks reported separately: No. of trucks	Trucks: No. of vehicle miles traveled (thousands)	Trucks: No. of accidents	Trucks: No. of accidents per 100,000 vehicle miles	Combination all cars and trucks reported: No. of cars and trucks	Combination: No. of vehicle miles traveled (thousands)	Combination: No. of accidents	Combination: No. of accidents per 100,000 vehicle miles
All departments													
1950..	158	21,313	371,168	2,783	0.75	28,506	434,587	7,086	1.63	61,950	980,933	12,283	1.25
1949..		20,707	362,213	2,989	0.82	27,015	393,624	6,774	1.72	57,373	948,187	12,700	1.33
1948..		19,250	333,315	2,900	0.87	23,358	346,890	6,772	1.95	49,685	815,957	12,075	1.48
1947..		21,351	362,697	3,218	0.89	24,279	359,685	7,902	2.20	50,930	818,781	12,914	1.58
1946..		17,346	286,770	2,294	0.80	21,147	285,365	6,078	2.13	42,487	633,343	9,500	1.50
1945..		18,824	279,617	2,204	0.79	26,316	360,838	6,059	1.68	45,520	644,954	8,280	1.28
1944..		19,913	279,314	1,928	0.69	27,576	366,185	4,576	1.25	48,057	652,515	6,568	1.01
1943..		18,817	242,311	1,595	0.66	25,985	366,082	5,381	1.47	45,032	612,927	7,014	1.14
1942..		19,418	276,668	1,938	0.70	26,566	392,940	5,954	1.52	48,097	698,382	8,164	1.17
1941..		21,933	418,063	3,727	0.89	28,058	430,348	7,627	1.77	51,703	873,714	11,799	1.35
Refining													
1950..	65	813	8,858	121	1.37	1,576	10,254	161	1.57	2,630	21,064	369	1.75
1949..		827	9,358	132	1.41	1,826	11,104	182	1.64	2,821	22,164	451	2.03
1948..		557	7,589	104	1.37	946	9,497	153	1.61	1,745	17,547	292	1.66
1947..		648	8,266	118	1.43	1,118	8,872	143	1.61	5,779	78,005	1,541	1.97
1946..		483	6,652	80	1.20	735	5,452	93	1.71	1,339	13,495	196	1.45
1945..		553	7,171	102	1.42	738	7,261	129	1.78	1,367	15,139	232	1.53
1944..		577	6,353	98	1.54	784	6,327	159	2.51	1,415	13,274	261	1.97
1943..		525	6,252	75	1.20	723	6,191	118	1.91	1,248	12,444	193	1.55
1942..		515	6,356	62	0.98	755	5,547	96	1.73	1,270	11,904	158	1.33
1941..		491	6,858	116	1.69	910	6,827	136	1.99	1,518	13,962	260	1.86
Production													
1950..	76	6,025	120,840	653	0.54	5,093	64,144	385	0.60	12,305	201,987	1,160	0.57
1949..		5,271	111,935	605	0.54	4,773	59,194	352	0.59	11,364	179,438	1,187	0.66
1948..		5,172	109,896	589	0.54	3,928	52,386	312	0.60	10,329	171,507	1,016	0.59
1947..		6,446	128,338	781	0.61	4,364	50,003	369	0.74	11,226	183,088	1,221	0.66
1946..		4,564	91,407	464	0.51	3,448	37,520	365	0.97	8,762	138,017	882	0.64
1945..		4,446	88,170	419	0.48	3,734	44,650	350	0.78	8,267	133,837	769	0.57
1944..		5,473	101,081	437	0.43	3,956	43,160	285	0.66	9,596	146,208	730	0.50
1943..		4,808	75,909	227	0.30	3,367	36,111	196	0.54	8,238	112,823	431	0.38
1942..		4,445	72,692	268	0.37	2,950	30,418	187	0.61	7,461	103,852	461	0.44
1941..		5,456	121,042	705	0.58	3,130	38,556	355	0.92	8,586	159,599	1,060	0.66
Pipe line													
1950..	74	3,444	63,983	349	0.55	3,757	59,494	373	0.63	7,557	129,988	764	0.59
1949..		2,934	51,097	292	0.57	3,107	47,767	321	0.67	6,412	111,123	713	0.64
1948..		2,706	46,725	260	0.56	2,417	37,792	265	0.70	5,360	94,222	598	0.63
1947..		2,508	41,470	274	0.66	2,286	34,136	255	0.75	4,864	76,677	550	0.72
1946..		2,071	32,708	174	0.53	1,709	24,472	185	0.76	4,035	60,718	385	0.63
1945..		2,047	34,021	180	0.53	1,524	20,590	149	0.72	3,595	54,940	329	0.60
1944..		1,896	31,542	131	0.42	1,941	19,948	115	0.58	3,859	51,819	247	0.48
1943..		1,684	25,348	103	0.41	1,232	14,478	83	0.57	2,916	39,827	186	0.47
1942..		1,469	21,010	101	0.48	1,317	16,973	112	0.66	2,786	37,983	213	0.56
1941..		1,426	28,107	202	0.72	1,076	16,545	141	0.85	2,502	44,652	343	0.77

This 1950 frequency rate is the lowest in four years. The rate of 1.25 per 100,000 vehicle miles is the lowest since 1945 and this is the third consecutive year there has been a decrease in this rate.

The extensive effort being made to reduce accidents is therefore showing the desired results even if the great objective of no accidents at all has not been reached.

Number of cars and trucks used by the total 214 companies reporting have increased from 50,000 in 1945 to 77,000 in 1950.

It must be remembered that the API report is based on a limited number of companies but it gives an insight into the use of motor vehicles in the industry as well as indicating the accident rate of the industry. * * *

NEWS

New Core Laboratory

Chemical and Geological Laboratories, Casper, Wyoming, has announced the establishment of a laboratory and office in Midland, Texas, to serve the Permian Basin with full diameter and routine core analysis. The branch will be known as Chemical and Geological Laboratories of Texas.

The new laboratory will be in operation by October 15, according to J. G. Crawford, president. Manager of the Midland branch will be Richard L. Brown, who is being transferred here from the chemical department in Casper where he has served since receiving his BS degree from the University of Wyoming. The company also has a branch in Alberta, Canada.

Wildcatter's Congress Formed

Charter for Wildcatter's Congress has been issued in Tennessee. The organization was established for the purposes of improving the effectiveness of wildcatters in meeting the need for new discoveries, advancing the work of wildcatters, increasing public understanding, and deepening the spirit of fellowship among wildcatters.

Plans include the publication of a monthly newsletter, quarterly journal and a "who's who" of wildcatting, annual awards for outstanding achievement, and the creation of scholarships for wildcatters or their children for research.

Eligible for membership are wildcatting operators, as well as geologists, engineers and other professional men who have had their share in wildcatting. Offices for the new organization are at 1422 K Street NW, Washington, D. C.

Saudi Arabia Crude Average Up

Crude oil production in Saudi Arabia during August amounted to 25,971,707 bbl, or an average of 837,797 bbl per calendar day, it was announced today by the Arabian American Oil Company.

Crude processed at the company's refinery at Ras Tanura amounted to 5,402,279 bbl, or an average of 174,267 bbl per calendar day.

Crude oil production for the first eight months of 1951 amounted to 172,891,511 bbl, an average of 711,488 bbl per calendar day. Crude run in the refinery for the same period was 38,619,143 bbl, an average of 158,927 bbl per calendar day.

Kuwait Export Record Hits New All-Time High

The tiny kingdom of Kuwait is now shipping some 20,000,000 bbl of oil a month compared with 13,000,000 bbl last January. Anglo-American-operated Kuwait Oil Company loaded 131 tankers in July and about the same number in August, a company spokesman reported. About 20 less would have been loaded were it not for the shutdown of Abadan and other Iranian operating points. The spokesman pointed out that the Iranian situation was only partly responsible for the new Kuwait export record. It is due mainly to Kuwait Oil Company's long-term expansion program, which reached its peak in the mid-1951.

Subsurface Correlation Discussed at AIME Meet

Junior section of Pacific petroleum chapter of the American Institute of Mining and Metallurgical Engineers held an open meeting at Rio Hondo Country Club, Downey, California, recently. Speaker for the evening was Henry M. Kilian, chief geologist for Oil Properties Consultants, who spoke on the application of differential thermal analysis to subsurface correlations.

The speaker stated that the purpose of his talk was to explain the potential application of differential thermal analysis to the problem of subsurface correlation and how it may be used to advantage in the absence of data from known techniques. DTA employs a method of analysis of clay as devised by Le Chatelier in some early studies ("The Action of Heat on Clays," Bull. Soc. Franc. Min. 10, pp 204-211, 1887). The process utilizes the principle of quantitative proportionality of a qualitative mineral constituent found to come

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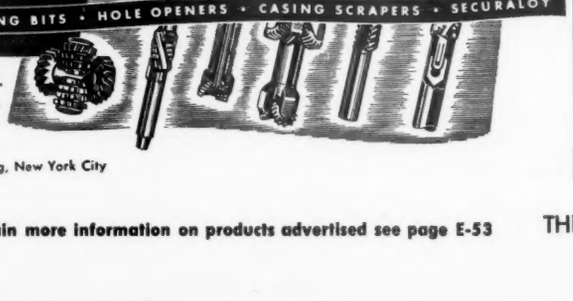

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from the same parent source, this constituent, in the case of DTA, being clay. Killian briefly mentioned the part clay analysis plays in the ceramics industry and discussed early experiments performed by people in that work which resulted in better, more consistently satisfactory, products.

Kilian pointed out that field development engineers at present have to rely on data from core analyses, paleontology, and various logging techniques for aid in subsurface correlation. In general, these means are satisfactory, but there are instances (for example in a long, monotonous shale section that is barren of microfaunal information) in which additional correlative tools are required. By utilizing to advantage the part that clays may play in the origin and accumulation of petroleum and in development practices, the speaker feels that differential thermal analysis as an analytical tool can and probably will play an important part in subsurface petroleum engineering and geological work in the future. In addition, as clays may also play a significant part in water flooding operations and other secondary recovery programs, the speaker feels that DTA will also have applications in this field. DTA is also able to isolate the presence of a fault in a long shale section that is void of microfaunal evidence and has been used to pick up unconformities.

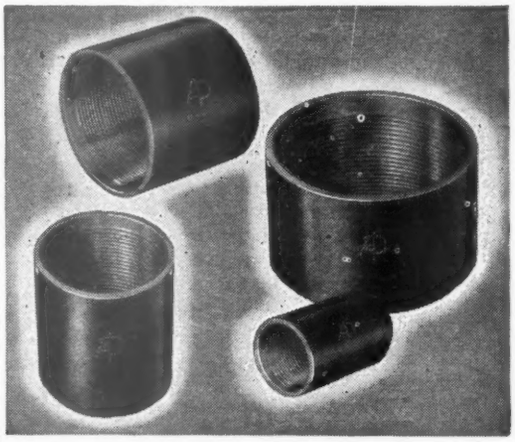
Kilian then discussed the principles of operation of DTA. He stated that when heat is applied to hydrous mineral substances, loss of water, oxidation, decomposition, and structural changes are known to occur. These reactions are accompanied by exothermic and endothermic effects. When the thermal effects of a sample are compared to a material that undergoes no thermal change (i. e., a "standard") a temperature difference results, which may be recorded, and the record of these heat changes plotted against temperature results in a differential thermal curve. The materials are both heated to 1000 C within a time period of one hour and a half, this particular period having been settled on as producing the most significant results without obtaining the unnecessary detail and possible anomalies that might result from a longer heating period. No especially significant results are obtained until the temperature rises above 573 C. This is the temperature at which Alpha quartz changes to Beta quartz and the more important breakdowns in the latticework of crystal structures occur, which apparently have an important bearing on the use of DTA for correlation. In summary, Kilian stated that through DTA, a qualitative analysis of a mineral sample is achieved through the application of heat.

The equipment employed for these operations consists of four main items; namely, an electric furnace, a control that assures a constant temperature rise, a sample holder and the various recording instruments. At present, Kilian stated, it is possible to run 12 samples per day, but that they hope to soon have in use a multiple recording device that could handle 100 samples a day.

The DTA process is primarily concerned with the clay mineral groups, consisting of kaolinite, montmorillionite, illite, the miscellaneous crystal group, and the amorphous group, each one of which, said Kilian, possesses a rigid crystal form and is fairly regular. Kilian stressed that the engineer must be aware of the genesis of a certain rock or rock series involved; that he must realize that clay can be the end product of a certain geologic process only so long as no environmental change takes place.

Kilian then illustrated graphically the results of some DTA that had been done in the East Venezuela field where considerable work had been done with this process. Ditch samples were used exclusively for obtaining the unknown sample and tops of microfaunal horizons were picked on the results of this work, which, after later information was obtained, checked excellently with zonal tops picked by micropaleontologists.

In closing, Kilian stated that he felt that DTA is a workable, practicable and fit tool; that it is easy to use as a correlative tool to anyone acquainted with logging; that it is fast and relatively inexpensive; that it permits better mud engineering as it gives a good mineralogical picture of the chemical composition of the formation being drilled through at the time. * * *



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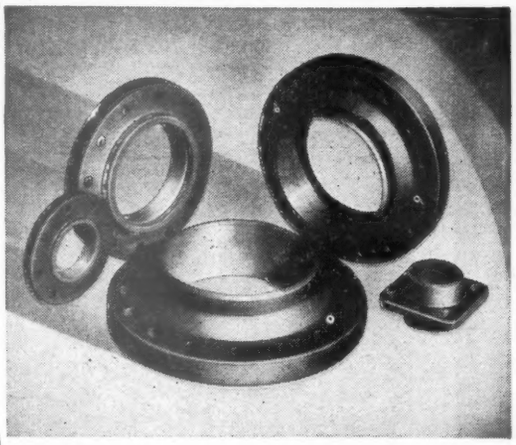

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Custom-Built Quality Products in Quantity
98 YEARS IN PENNSYLVANIA'S CAPITAL

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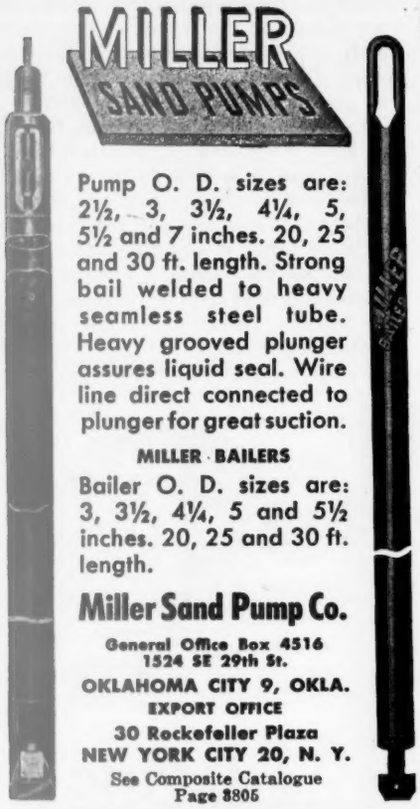
Clean Out Better With



Pump O. D. sizes are: 2½, 3, 3½, 4¼, 5, 5½ and 7 inches. 20, 25 and 30 ft. length. Strong bail welded to heavy seamless steel tube. Heavy grooved plunger assures liquid seal. Wire line direct connected to plunger for great suction.

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Bailer O. D. sizes are: 3, 3½, 4¼, 5 and 5½ inches. 20, 25 and 30 ft. length.

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See Composite Catalogue Page 3805

Magnolia Crude Reserves Top Billion Barrel Mark

Magnolia Petroleum Company, Socony-Vacuum affiliate had estimated crude oil reserves of 1,161,705,000 barrels on January 1, 1951, according to company officials in their first statement on how much potential crude oil Magnolia has in the ground. Magnolia's 1161 million barrels compares with gross U. S. crude oil reserves of 1491 million barrels for Socony's entire domestic operations at the end of 1950.

Magnolia officials also disclosed the company, as the year started, had completed 766 wells from which it was producing an average of 157,000 gross barrels of crude oil daily. Since then, as a result of the company's strong position in the Kelley-Snyder field in Scurry County and several fields in the Spraberry trend, this daily average has been stepped up.

Sees End of Steel Shortage

The steel shortage should end within the next 12 to 24 months, barring a "red-hot" shooting war, J. L. Hamilton, Jr., vice president of Granite City Steel Company predicted in a Houston speech to American Steel Warehouse Association. Hamilton based his forecast on a $5 billion industry expansion program to boost steel production capacity to about 120 million tons a year by 1953.

Torrey, Cushman Open Offices and Laboratory

A general partnership has been formed by Paul D. Torrey and Allerton Cushman known as Oil Recovery Chemicals. Offices and laboratory have recently been opened at 705 Lamar Boulevard, Austin, Texas.

Oil Recovery Chemicals is the exclusive representative of Armour and Company of Chicago, Illinois, for the sale and application of surface active compounds and other chemical products used in the production of oil and gas and for other related operations of the petroleum industry in the states of Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

It is also special representative of Oil Recovery Corporation, New York, New York, for the application of their Orco process (carbonic acid process) to certain reservoirs to increase oil recovery.

Deep Rock Sells Acreage To Champlin Refining

Deep Rock Oil Corporation recently sold 170,000 acres of its Williston Basin leasehold in Montana and North Dakota to Champlin Refining Company for an undisclosed cash consideration. The sale was announced jointly by J. Lawrence Muir, executive vice president of Champlin, and John L. Ferguson, Deep Rock vice president in charge of land and exploration.

The acreage involved in the sale is in 21 North Dakota and 4 Montana counties and includes blocks as well as checkerboard leases.

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SERVICE, INCLUDING
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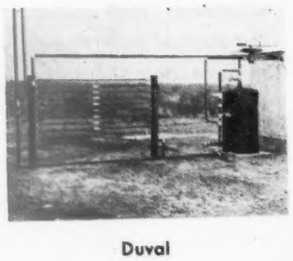

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County,
Texas.

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ESTIMATES
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SUPERVISION

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WICHITA FALLS, TEXAS

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5,000 watts, D.C.

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● ONAN oilfield electric plants provide dependable light and power for oil field applications. A complete range of A.C. and D.C. models . . . all conservatively rated for continuous, dependable service helps you choose the right plant for the job. Lightweight, air-cooled models from 400 to 5,000 watts; heavy-duty, water-cooled, gas-gasoline-driven plants from 5,000 to 35,000 watts. Air-cooled Diesel electric plants 2,500 watts. Water-cooled Diesels from 12,500 to 55,000 watts, powered by IH engines.

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SIZES FOR ALL WIRE ROPE
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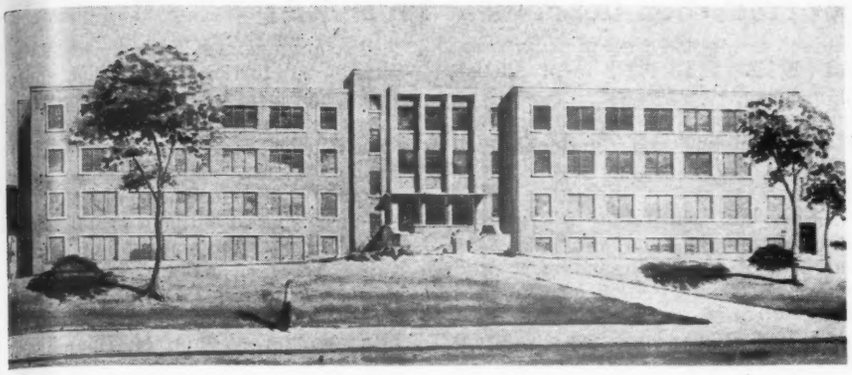

Petroleum engineering school of the Colorado School of Mines will be housed in classroom and laboratory structure upon its completion, scheduled for September, 1953. Outstanding features of the four-story brick building will be: A 50-ft steel oil well derrick containing pumping equipment to operate a 10-in. well driven 100 ft into the ground under the building basement, separate laboratory facilities for petroleum students, graduate students, and faculty research workers, a refrigerated room for exceptionally low temperatures and ample storage space for oils and chemicals.

Texas Allowable Raised

The Texas Railroad Commission set as the October allowable for Texas crude oil production a record 3,115,512 bbl daily, a net increase of 5541 bbl. One full day was added to the state level of production, with 25 days permitted, except in the East Texas field, which keeps it present quota of 19 days.

The Commission warned that unless the flaring of natural gas is reduced there may be a reduction of the number of producing days. The Commission noted that, while the amount of oil produced between January and July of 1951 had increased 8.61 per cent, the volume of gas flared increased 137 per cent.

The Commission also reported that the average well-head market price for sweet natural gas in the Panhandle area had increased .4265 cents per thousand cubic feet over last year. Texas law does not permit the Commission to fix prices, but allows it to determine a fair market price for the Panhandle field.

"The Greatest Name in Cable Tools"

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TRUSTWORTHY SINCE 1900

PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION MEMBER

Fig. 179 Acme W. L. Knife Cutters

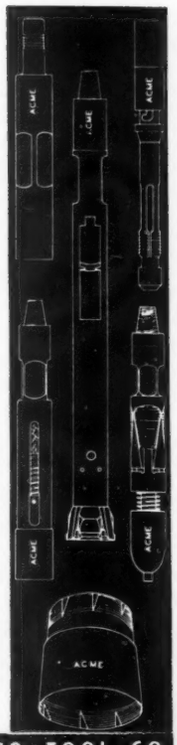
See Acme's Insert in 1951 Composite Catalog. Also write for more complete Catalog, containing valuable cable tool "use and care" manual.

. . . to-be-Sure — Always Ask for Acme's W.L. Cutting Outfit

"Acme's WL Cutting Outfit is MOST Safe, Sure, Quick, Clean-Cutting means of parting cable from stuck tools," say Driller-owners.

Its EXCLUSIVE feature is cutter's assemblage: Cutter-edges so spaced that each snips separate cable-strand, yet altogether cutting 6-strands at 1-clean "bite." No frayed ends. Cuts cable in 4" hole or larger. Smaller on special order. Outfit consists of Knife, Jars, Sinker, Rope Socket, Wrenches. With simple precautions, runs without wrapping.

Unique, patented design of life-long driller. Every part meets ALL correct-steel, controlled heat-treatment and precision-crafted standards, making Acme's famous-favorites since 1900.



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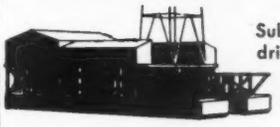
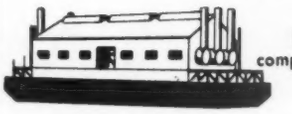


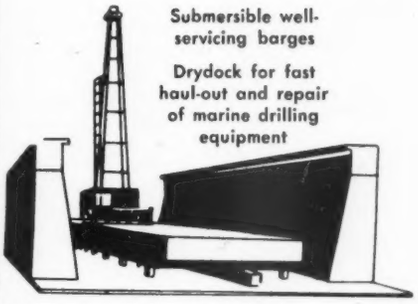
Submersible drill barges

Tugs



Boiler and compressor barges

Water, oil, and supply barges



Submersible well-servicing barges

Drydock for fast haul-out and repair of marine drilling equipment

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Orange, Texas

Sunray Adds to Staff and Revises Production Department Supervisors

Elwood L. Baldwin, reservoir engineer, William D. Elliott, petroleum engineer, Frank C. Folger, Jr., petroleum engineer, Wayne C. Moody, mechanical engineer, and John D. Walters, petroleum engineer, were added recently to Sunray Oil Corporation's production department staff. Baldwin comes to Sunray from Sun Oil Company, Mt. Pleasant, Michigan, and was formerly associated with Champlin Refining Company, Enid, and Mid-Continent Petroleum Corporation, Tulsa. He is a graduate of the University of Oklahoma, and Tulsa.

Elliott was formerly associated as engineer with Atlantic Refining Company, Gulf Oil Corporation, and Core Analysis Laboratories, holds a BS in engineering and physics, and an MS in production engineering.

Folger, formerly with Stanolind Oil & Gas Company and Continental Oil Company, is a graduate of University of Oklahoma.

Moody has joined Sunray from the National Supply Company, where he had been division sales engineer, and holds a mechanical engineering degree from University of Arkansas. Walters has joined Sunray from work with various oil companies in Pennsylvania and Wyoming in engineering capacities. He is a graduate in petroleum engineering from the University of Oklahoma.

A re-alignment of Sunray Oil Corporation's production department supervisors and field offices to de-centralize activities so as to allow a more flexible operation has been announced by H. O. Harder, Tulsa, vice president for the company's Mid-Continent division.

Sunray's Mid-Continent producing division includes the states of Oklahoma, Kansas, Texas, Arkansas, Louisiana, Mississippi, New Mexico, Colorado, and Wyoming. Division superintendent is J. R. Vandever; John H. Douma and C. J. Kerwin are assistant division superintendents, Douma supervising operation in Arkansas, Louisiana, Mississippi, and Gulf Coast Texas, and Kerwin supervising operations in North and West Texas, Oklahoma, New Mexico, Kansas, Colorado, and Wyoming.

In the new organizational setup, Sunray has created operating districts within the Mid-Continent division mainly corresponding to the state boundary lines. Each district is headed by a district superintendent and some of the districts have assistant district superintendents.

Field operations are supervised by the district offices in "areas," representing large segments of field operations within the district, and "groups," which are mainly lease operations within limited areas of state districts. Each of the areas is supervised by a field superintendent, and the lease groups are supervised by a lease foreman or a group foreman, who may be responsible for a group of leases in an operating area.

The production department personnel heading these districts, areas, and groups in Sunray's Mid-Continent division, are announced as follows:

South Louisiana District: Headquarters at Lake Charles, Louisiana, A. E. Hoffman, superintendent, J. A. Peery, assistant superintendent; West Tepetate area, D. J. Hoover, West Tepetate, Louisiana, field superintendent; Longville group, H. O. Jones, group foreman.

Tri-State District: Midway, Arkansas, Keith Lindley, superintendent; Midway, North Louisiana, and Northeast Texas groups, J. T. Davidson, group foreman.

Corpus Christi District: Corpus Christi, Texas, A. E. Hoffman, acting superintendent, G. E. McClatchey, assistant superintendent; Corpus Christi area, J. M. Goodman, Corpus Christi, field superintendent; Corpus Christi Bay group, A. O. Miller, lease foreman.

South Texas District: Alice, Texas, C. E. Wilson, superintendent, F. S. Goddard, assistant superintendent; McFaddin Nordheim area, Nordheim, Texas, H. E. Fish, field superintendent; McFaddin and Greta groups, C. B. Wright, lease foreman; Nordheim group, A. E. Meissner, group foreman.

South Texas District: Premont area, Premont, Texas, C. D. Baker, field superintendent; West Premont, Seeligson, and London Gin groups, J. M. Leach, lease foreman.

South Texas District: Placedo Pierce

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Junction area, Placedo, Texas, J. R. Myrick, field superintendent; Placedo group, T. Williams, lease foreman; Pierce Junction group, R. D. Mapes, acting lease foreman.

South Texas District: Hebbronville area, Hebbronville, Texas, J. A. Parry, field superintendent; Glen group, R. B. Caskey, lease foreman; Bruni and miscellaneous groups, C. L. Fenley, lease foreman.

North and West Texas District: Midland, Texas, Perry A. Gill, superintendent; Snyder area, Snyder, Texas, L. L. Peek, field superintendent; Canyon group, C. T. McClanahan, lease foreman.

North and West Texas District: Odessa area, Odessa, Texas, L. E. Pruitt, field superintendent; Levelland group, F. R. Hunt, lease foreman; Sherrod group, N. E. Clegg, lease foreman; Ector group, J. S. Newcomb, lease foreman.

North and West Texas District: Big Spring area, Forsan, Texas, C. C. Brunton, field superintendent; Dora Roberts group, H. W. Andrews, lease foreman; KMA group, O. G. Smith, lease foreman.

North and West Texas District: Pampa group, H. H. Echols, lease foreman.

North and West Texas District: New Mexico area, Hobbs, New Mexico, A. S. McQuiston, field superintendent.

Kansas District: Great Bend, Kansas, C. C. Shreve, superintendent, F. M. McDaniel, assistant superintendent; Ellis area, Russell, Kansas, G. D. Boyle, field superintendent; Hays group, C. M. Graham, lease foreman; Russell group, N. J. Gooch, group foreman.

Kansas District: Madison group, Alva Sutton, lease foreman.

Kansas District: Burrton area, Burrton, Kansas; Orville Hilbert, field superintendent; Sabin group, E. H. Winesburg, lease foreman; Rainbow Bend group, A. D. Passmore, lease foreman.

Kansas District: Barton area, Bushton, Kansas, W. D. Poe, field superintendent; Trapp group, A. J. Warren, lease foreman; Bloomer group, O. M. Light, lease foreman.

Oklahoma District: Oklahoma City, Oklahoma, Alvin R. Summers, superintendent; V. L. Smith, assistant superintendent; Seminole area, Wewoka, Oklahoma, J. F. Dingee, field superintendent; Allen-Bebee group, Tom Jacobs, group foreman, T. C. Anderson, lease foreman; Earlsboro group, Parker Sullivan, group foreman, E. E. Hill, lease foreman; Wewoka group, W. A. Drain, group foreman.

Oklahoma District: Western area, Oklahoma City, Oklahoma, I. T. Simmons, field superintendent; Comanche group, A. J. Wise, group foreman, Paul Anduss, lease foreman; Oklahoma City group, Charles Eastham, group foreman, W. L. Mastin, lease foreman; Perry group, C. R. Shepherd, group foreman.

Oklahoma District: Osage area, Barnsdall, Oklahoma, R. R. Rothrock, field superintendent; Avant group, A. R. Griggs, lease foreman; Bartlesville group; J. R. Brown, lease foreman; Bigheart Pershing group, Edgar Olsen, lease foreman; Delaware Flatrock group, Clyde Smoot, lease foreman; Wildhorse group, E. D. Fritz, lease foreman.

Wyoming Group: Thermopolis, Wyoming, C. A. Daugherity, group foreman.

Northwest New Mexico Group: Aztec, New Mexico, Gene Heath, group foreman.

Lewis Engineering Moves

James A. Lewis Engineering, Inc., petroleum reservoirs analysts has announced removal of its offices in Dallas, Texas, to 1518 Kirby Building. Telephone number is RIverside 3997.

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Reda Pumps produce the largest volumes obtainable from 5½", 7", 8⅝" casings, often reducing the required number of source wells. Corrosion resistance built into Reda Pumps materially prolongs time between pulling jobs, where corrosion is a factor.

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Reda Pumps reduce investment in number of supply wells required. Reda pumping equipment investment is less per barrel of daily capacity; pumping cost per barrel is lower.

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To fit the changing needs for water volume as the flood progresses, Reda Pump can readily be altered or changed to larger or smaller sizes.

Reda Engineers have been closely associated with WATER FLOOD OPERATIONS for more than ten years and are fully qualified to assist operators in the selection of proper pumping equipment. A letter or phone call will bring prompt results.

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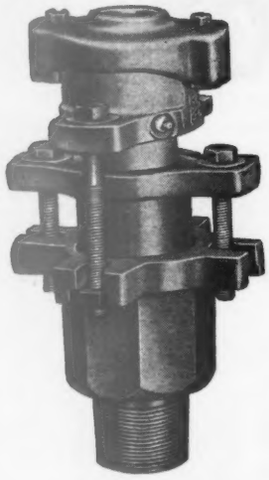
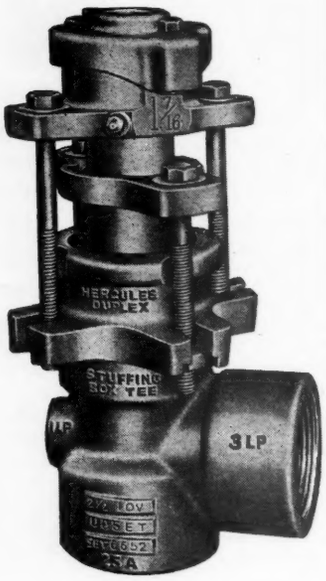
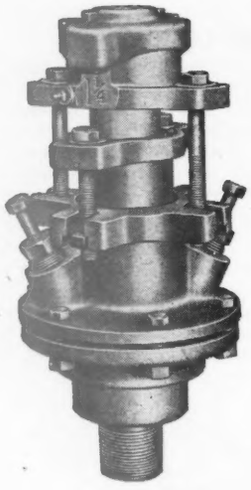


All Hercules Duplex Polished Rod Stuffing Boxes are Cone Packed for longest possible life and greatest economy. Illustrated (left) is Regular Type. Write for Bulletin 120-SB.

The Tee-Base Type Combination Stuffing Box and Tee (directly below) have been proven by years of service and savings to producers. Write for Bulletin 121-SBT.



A double packed Stuffing Box for use under most adverse pumping and flowing conditions (below). Be sure to order Type A-123-SBDP.



For greater savings, replace old style Upper Glands with the New Hercules Lubricating Upper Gland, as shown on Stuffing Boxes illustrated.

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General Office and Plant: 17th and Phoenix P. O. Box 286 — TULSA, OKLAHOMA — Telephone 3-1186 Cable Address "HERTOCO"

IPAA Studies International Oil Problems

The Independent Petroleum Association of America has initiated a study of Western Hemisphere petroleum and its relationship to the security of the United States and the hemisphere. Charlton H. Lyons, Shreveport independent oil man who is chairman of the committee, announced the group had adopted a program of study at its meeting in Fort Worth.

Lyons cited as examples of current problems affecting U. S. and hemisphere oil the temporary dislocation of petroleum moving in world channels from Iran, the scheduled renegotiation of the Venezuelan Trade Agreement and the shortage of steel so vitally necessary to the industry's ability to find and develop adequate oil supplies.

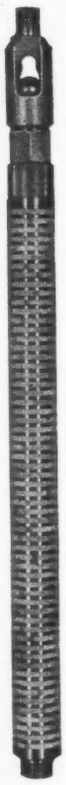
While the committee's study will be on a hemisphere basis, it is planned its report will be by countries. Its study will cover present and prospective productive capacity and known reserves, present and prospective demand, refining capacity.

UNITED STATES OF VENEZUELA*

Technical Office of Petroleum, Bureau of Mines
Crude oil production in Venezuela during 1947, 1948, 1949, 1950, and 7 months of 1951. Average in barrels per day.

Companies	1947	1948	1949	1950	Average 1951 7 months
Creole	625,357	683,531	624,505	685,839	765,727
Shell	331,192	396,990	409,983	461,601	515,536
M.G.O.	174,604	182,131	169,191	202,211	240,278
Socony	27,798	30,464	35,951	37,003	46,872
Texas	8,819	13,278	23,357	25,711	24,591
Mercedes	169	6,952	15,581	18,706	22,712
Atlantic	92	3,053	11,692	20,944	19,810
Richmond	—	765	3,629	12,502	14,522
Sinclair	21,661	18,469	15,190	12,598	11,892
Pantepec	—	—	6,274	12,318	10,302
Phillips	370	1,786	4,852	7,492	6,264
British	1,157	1,111	1,063	995	962
Guasare	5	—	99	65	2
Others	254	264	—	—	—
Total	1,191,478	1,338,794	1,321,367	1,497,985	1,679,470

* Reported by Minister of Mines and Petroleum of Venezuela.



Pulling too often - - - - - - ?
Costly pump repairs - - - ?
Lost production - - - - - ?

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√ Martin Cages

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They do the job.

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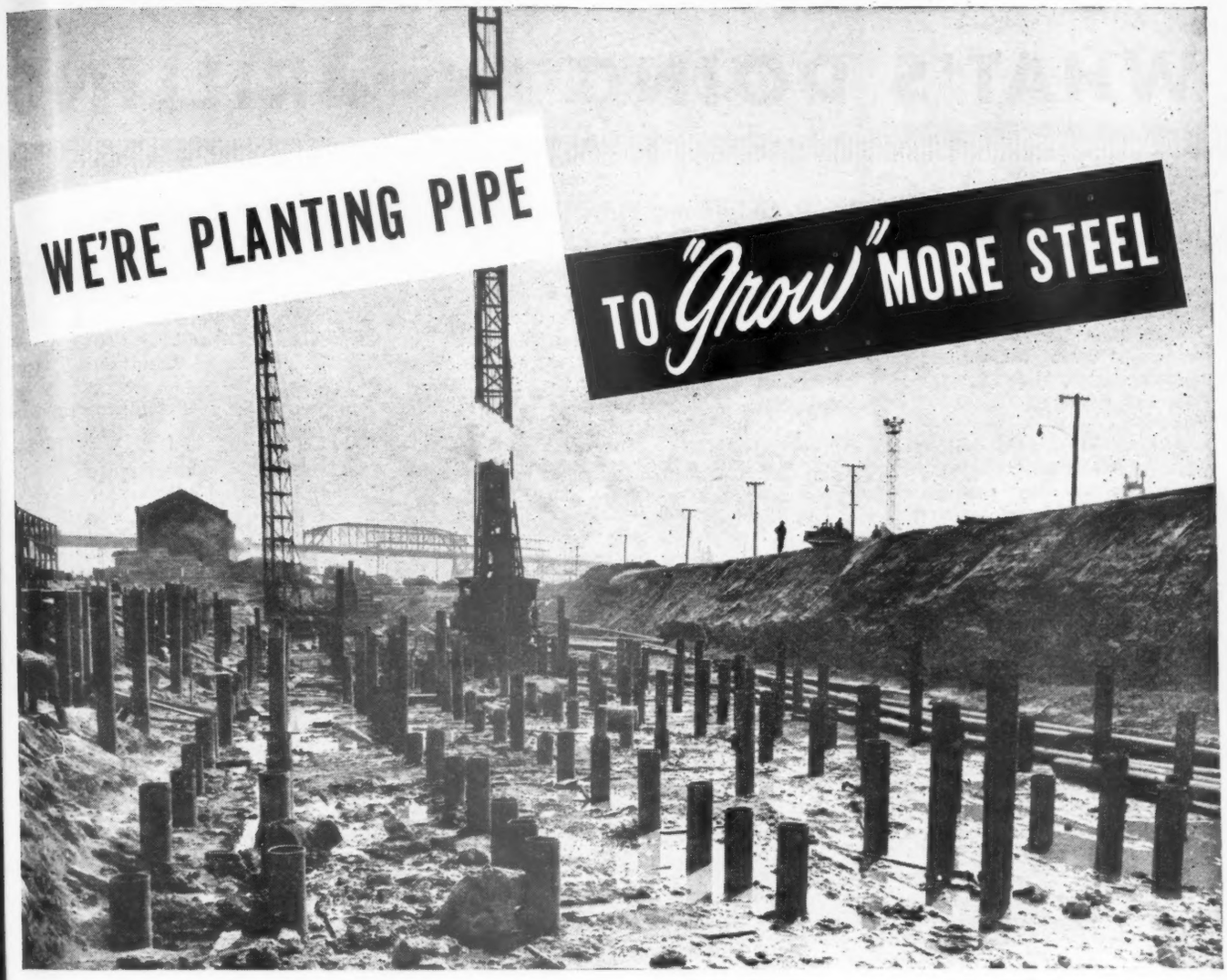
Don C. Davis, Tel. Wilson 8055, Fort Worth
Tom Hulett, Tel. 3-4545, El Dorado, Ark.
L. K. Martin, Tel. 2-5317, Corpus Christi
J. L. Davis, Tel. Mohawk 4891, Houston

For Rod or Tubing Pumps

JOHN N. MARTIN, MANUFACTURER
9 W. Brady St., Tulsa, Okla. Tel. 4-9415



● *672,000 new net tons of steel per year*—that's the goal of Republic's latest $75,000,000 expansion program in the Cleveland district.

But, making steel *takes* steel . . . many, many tons. For example, Republic must "plant" more than 1,194,000 feet of 10¾" Electric Weld pipe. This pipe will serve as piling driven 110 feet into the earth to support four new 275-ton open hearth furnaces. More steel must be diverted to the construction of a new blast furnace, coke ovens, a reducing mill and soaking pits.

This program is a major part of Republic's share in expanding the nation's annual steel production potential to 117,500,000 tons by late 1952. First steel from these facilities is scheduled to be poured early next year. This means more steel for defense, and for all products of American industry.

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WHAT'S DOING IN DRILLING

Sunray Completes Gas Well In San Juan, New Mexico

Sunray Oil Corporation has completed its first well in its New Mexico development program. It is the San Juan No. 1, San Juan County, which is in the process of testing for completion. Tests to date indicate this No. 1 well is capable of producing 2,500,000 cu ft of gas daily.

Although the rated daily producing capacity is relatively small the total gas reserve in this area is estimated to be quite large. It is contemplated that active drilling of these reserves will be continued.

Sunray's new well was drilled to a total depth of 5617 ft in the Point Lookout sandstone.

Oklahoma Field Well Is Drilled in Elk City Field

The Beckham County, Oklahoma section of the Elk City field which has been coming up with new producers almost continuously, is the scene of a new Shell Oil Company well, the No. 2 Mikles. Drilled to a total depth of 10,197, the new well flowed 141 bbl of 63 gravity condensate in 12 hours. Gas-oil ratio was 9339 to 1. Recovery was 80 ft of condensate without any water.

California Well Flows

Morton A. Sterling, petroleum engineer and vice president of Sunset Oil Company, has announced completion of Padre No. 12, the first well drilled since acquisition of the Padre and Mission oil properties in Raisin City, California by the Eagle-Sunset interests. The well came in flowing at the rate of 240 bbl a day, through a 10/64 in. bean.

Arkansas Well Flowing From Cotton Valley Zone

Pan Am Southern Corporation has opened Cotton Valley production in the East El Dorado field in Union County, Arkansas. The new well is the company's No. 1 Ezzell, which flowed 75 bbl of oil a day through a 1/64-in. choke. It is producing from 5026-28 ft.

Shell Completes Two Wells In Ventura, California

Shell Oil Company has reported two new wells completed in the Ventura Avenue field, California. The first well, Taylor 345, was drilled to 11,405 ft, from which it flowed 1297 bbl of oil 30.6 gravity crude oil through a 14/64-in. choke. The second well is flowing 694 bbl daily through a 14 25/64-in. choke. It was drilled to 8470 ft.

Oklahoma Firm to Study Digboi Oil Field in India

Keplinger and Wanenmacher, petroleum engineers, Tulsa, Oklahoma, has been given an assignment to study reservoir and operating problems of the Digboi field in India for the Burmah Oil Company, Ltd.

Henry Keplinger left recently to visit the field, which is situated northeast of Calcutta near the China-Burma border. He will go to London for a short stopover and then proceed to Calcutta, India, by way of Egypt, Bahrein Island and Karachi. Keplinger expects to be gone three or four weeks on this preliminary survey.

Utah Gas Field Sought

Mountain Fuel Supply Company and Stanolind Oil and Gas Company will work together to develop a gas field on the Utah-Colorado border, it was recently announced. Four wells will be drilled on the Rabbit Mountain-West Douglas creek field, which was discovered by Roy M. Johnson, Ardmore, Oklahoma and John R. Bunn, Tyler, Texas.

California Well Completed

In the South Cuyama field of California, Richfield Oil Corporation has recently completed its J. G. Herren A. No. 33-35 oil well. Production rate of the well was set at 283 bbl daily of 31.8 gravity crude oil through a 32/64-in. bean. The well was drilled to 4490 ft.

Well Completed for 250 Bbl

Mid-Continent Petroleum Corporation has completed its No. 8 Inghram in Lincoln County, Oklahoma. The new well flowed 250 bbl of oil in 24 hours through a ¾-in. choke. No. 1-B Ingram is drilling at 2995 ft.

Sunray to Extend Waterflooding Projects

Sunray Oil Corporation has acquired 825 developed acres in the North Ochelata field, Osage County, Oklahoma, and will turn the 46 producing wells on the lease into a proposed waterflood project encompassing more than 1000 acres.

The wells are predominantly Bartlesville sand production at 1500 ft and were acquired from A. W. Busmann, Copan, Oklahoma, and O. A. Patridge, Dewey, Oklahoma, for an undisclosed sum. In addition to the oil wells, seven gas injection wells and two salt water disposal wells are included.

The wells acquired by Sunray adjoin offset acreage to the north on which Sunray currently has a pilot waterflood project in operation and the company proposes to combine the properties.

New Well Drilled in Cowpen Creek Field

A new well flowing 119 bbl of oil daily was completed in Cowpen Creek field of Beauregard Parish, South Louisiana. It is Fidelity Oil and Royalty Company's No. 5 Edgewood Land and Logging Company. Flow was through 7/64-in. choke from 8552-59 ft. Gas oil ratio was 2012 to 1.

Gas Field in Louisiana Gets Its First Oil Well

The first oil has been discovered in the Downsville field of Union Parish, Louisiana, since the pool was opened in 1948. Discovery well was completed as a gas condensate. The oil well was drilled by Phillips Petroleum Company and is the company's No. 1 Roberts. It flowed at the rate of 365 bbl of 41-gravity oil daily through a ¼-in. choke from perforations in the Travis Peak. Flow was from 7418-24 ft in depth, with tubing pressure of 850 lb and gas-oil ratio of 863-1.

Deeper Zone Opened In Arkansas Field

A deeper producing zone has been opened in the Cecil field of Franklin County, Arkansas at Arkansas-Louisiana Gas Company's No. 1 Davis-Dunn Unit, a dual completion well. The new well was completed for 7,000,000 cu ft of gas a day from the Hale sand zone at 4758 ft to 4830 ft, and for 10,000,000 ft of gas a day from the Atoka section at 3682 to 3920 ft.

Magnolia Well Extends West Texas Oil Field

Magnolia Petroleum Company has extended the Parks field of Midland County, West Texas with completion of its No. 1 Claude Back. The new well, which extends the field eastward, had a daily flow potential of 599 bbl of 43.8 gravity oil, with a gas-oil ratio of 1768-1. Production was through a 2/64-in. choke and perforations between 10,540-10,555 ft. The field is producing from the Pennsylvanian zone.

Utah Field Gets New Oil Producing Zone

A new well in the Duchesne field of Duehesne, Utah has been completed by Carter Oil Company. Drilled to a depth of only 3000 ft, the new well, the No. 2 Ute Tribal, is significant in that it may mean an increase of the potential capacity of the field. Other wells in the Duchesne field have been completed at a depth of 7496 ft in the Wasatch formation. The new well is producing from the Green River zone.

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Magnolia Designs Clay Mud Saver

Losses of drilling muds up to $50,000 per well are sometimes incurred when oil wells are drilled through porous or cavernous underground formations. Annual industrywide drilling costs which can be traced directly to lost circulation of muds run into the millions of dollars. To partially offset such losses, a new clay cement has been developed by the Field Research Laboratories of Magnolia Petroleum Company, an affiliate of Socony-Vacuum Oil Company.

The cement is designed to close off the permeable zones in which losses occur after they are encountered by the drilling bit. Thus loss of expensive mud, used for lubrication of the bit and for carrying off cuttings, can be averted.

Magnolia executives announced that technical details of the development will be presented next week by T. A. Pollard, J. U. Messenger and J. S. McNiel, Jr., staff members of the Field Research Laboratories, at the fall meeting of the American Institute of Mining Engineers, Petroleum Branch, in Oklahoma City, Oklahoma.

They added that the new time-setting clay cement has been successful in field tests for plugging off mud-loss zones where other more conventional materials failed. It also obviates excessive requirements of casing, cement, rig time, and the blowout hazards attendant to lost circulation.

Basically, Magnolia's new clay cement consists of an aqueous slurry of a specially selected clay, a smaller amount of an aluminum silicate to increase the strength of the clay after it sets, and a retarder for increasing the time during which the slurry can be pumped before it starts to set.

In a relatively short time after the mixture is pumped down to the permeable zone, the clay cement becomes plastic with sufficient strength to seal off the zone against mud losses during subsequent drilling operations.

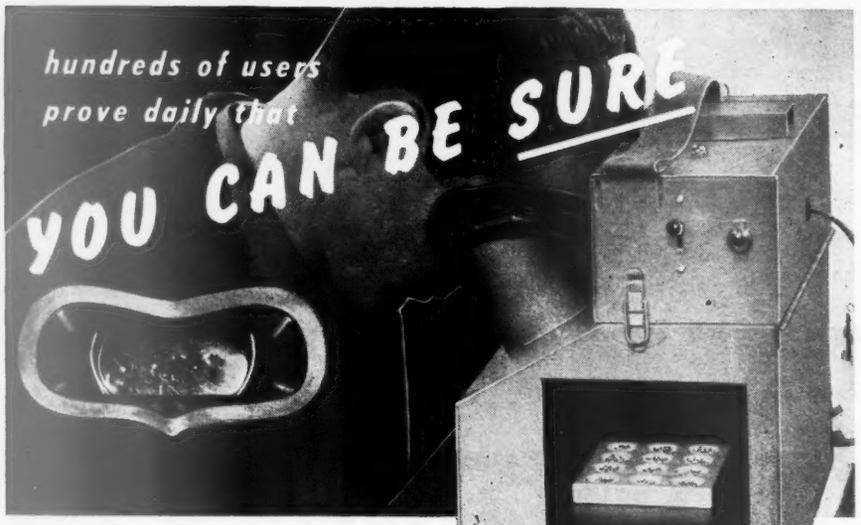
Magnolia executives said their new clay cement is preferably placed in a well by standard cementing equipment where the solids and water are jet-hopper mixed and then pumped directly into the drill pipe.

In certain areas, particularly in application to shallow loss zones, it should be feasible to utilize regular mud pumps.

Rotary rigs operating in oil fields of United States and Canada.*

Weeks (August)	Total	Gulf Coast	Pacific Coast	Illinois Oklahoma Kansas	Arkansas Louisiana Texas	Rocky Mountain Canada	New Mexico West Texas
Third	2868	589	169	677	155	318	960
Fourth	2874	592	186	653	160	348	872
(September)							
First	2927	601	183	642	166	358	987
Second	2940	608	184	633	175	244	996
Third	2898	595	186	627	176	342	972

* As reported to the American Association of Oilwell Drilling Contractors by Hughes Tool Company.



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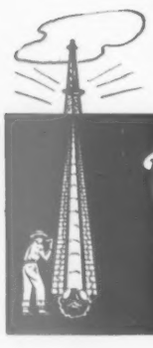

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- Rotary Engineers Limited—Edmonton, Alberta, Canada
- Triangle Blue Print & Supply Co.—Oklahoma City and Tulsa, Okla.
- Greene Brothers Inc.—Dallas, Texas
- W. H. Curtin & Company, Domestic and Export, Houston, Texas, and New Orleans, Louisiana

Midco Completes Well In Naval Reserve Pool

The Northwest Naval Reserve pool of Osage County, Oklahoma has a new well that is flowing 289 bbl of oil in 12 hours. The new well is Midco Oil Corporation's producer, No. 3 Osage, which has been drilled to a total depth of 2722 ft. It was shot with 92 qts between 2670-2710 ft with 7-in. casing set at 2641 ft, after which the flow was made. Oil was 40 gravity.

Two Venezuelan Wells Drilled by Pantepec Oil

Two new wells have been completed in Antzoategui, eastern Venezuela by Pantepec Oil C. A. The first well is producing 650 to 700 bbl a day of high gravity oil from a depth of 6600 ft. It is situated in the El Roble concession and is the company's RPN-27.

Pantepec's other new well in the El Roble concession is about 7 miles east of the RPN-27, and has been placed on production at a rate of 650 bbl a day of 42 gravity oil.

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EXPLORATION ACTIVITIES

Gulf Wildcat in Canada Indicates New Discovery

Gulf Oil Corporation has reported discovery in a wildcat well, Gough No. 10, in western Canada. Situated about eight miles south of producing fields at Stettler and seven miles north of Big Valley, the well indicates that the company may have a discovery of major proportions. Production was obtained at 5175 to 5211 ft in the D-2 zone of Devonian formation. On drillstem test for 30 minutes, gas came in after five minutes and oil after 25 minutes. Preliminary estimates of the well's production were set at 1700 bbl per day from 36 ft of producing area thus far penetrated. The oil is 31 gravity at 60 F. Drilling to determine if oil is present at lower depths is continuing. It is expected that the D-3 zone of Devonian will also be productive.

Mid-Continent Discovery Made in West Texas

In Callahan County, West Texas, Mid-Continent Petroleum Corporation has completed an Ellenburger discovery. It is the company's No. 1-A B. Odom wildcat well, 12 miles southeast of Baird, which flowed 42 gravity oil at a rate of 15 bbl hourly on a 2-hour drillstem test between 4167-4177 ft. Gas showed at the surface in 2 minutes, mud in 12 minutes, and clean oil in 14 minutes.

Skelly Wildcat Shows Oil In Six Different Zones

Skelley Oil Company has completed an Ellenburger wildcat in Lea County, New Mexico, which showed for production from six different zones. It is the company's No. 1-J Mexico-State, which was completed for a 24-hr flowing potential of 583 bbl of 41.8 gravity through a ¾-in. choke from perforations between 10,210-10,320 ft in the bottom of the Ellenburger. The new well has been assigned a daily allowable of 243 bbl of oil and placed on production. Other productive zones were the Queen sand, Wichita-Albany, Clear Fork, Devonian, and Fusselman.

Cities Service Oil Stakes Shallow Water Oil Test

A 12,500-ft Miocene test in the shallow water of West Cote Blanche Bay in St. Mary Parish, Louisiana, has been announced by Cities Service Oil Company (Delaware). The wildcat is Cities Service No. 1 State Lease 3370, situated 350 ft west of the nearest point on the northwest shoreline of West Cote Blanche Bay. The Cities Service test is 4 miles northeast of the Lake Sand field, nearest production, and 6 miles northwest of the Bayou Sale field.

Gulf, Melben Lease Mississippi Lands

Gulf Refining Company and Melben Oil Company have obtained a long-term lease on 800,000 acres of state-owned tidelands in Mississippi. The companies, in a joint announcement, reported that exploratory work will begin at once. A well is to be drilled within one year, and a lease bonus of $50,000 was paid.

Melben Oil Company is three-eighths owned by Plymouth Oil Company, a Benedum firm, and Gulf Refining is wholly owned by Gulf Oil Corporation.

Gulf Drills Nebraska Well

In Kimball County, Nebraska, Gulf Oil Corporation is completing its No. 1 Sisson. The new well is Gulf's first venture in the western Nebraska area. Drilled to 7431 ft, pipe was set, then perforated in the "J" sand at 7326-54 ft. On initial test it swabbed and flowed 160 bbl of 38 gravity oil in 13 hours. A large pump is being installed.

Texas Well Flows 270 Bbl Per Day

A well flowing at the rate of 270 bbl of 55.2 gravity distillate and 2,000,000 cu ft of gas a day has opened a new field in Anderson County, East Texas. It is The Texas Company's C. W. Hanks No. 1, which is flowing from perforations at 10,090 to 10,104 ft. Production was made on a 10-hr test with a 11/64-in. choke. Tubing pressure was 3700 lb, and gas-oil ratio was 7400-1. It is 7½ miles northeast of the nearest production in the Blackfoot field.

Amerada Hits New Oil Zone In Huge Williston Basin

Amerada Petroleum Company has hit its second oil well in North Dakota. It is the company's No. 1 Harry Bakken, Williams County, which flowed oil on a drillstem test. Test was made at 8304-17 ft with oil flowing in 40 minutes and continuing to flow into pits for 20 minutes. No estimates were made, and crews were going ahead below 8360 ft. The Bakken is 12 miles north of the company's No 1 Iverson, which opened production in the huge Williston basin.

Zululand Survey Urged

In South Africa J. H. Viljoen, Minister of Mines still hopes that some day oil will be found in Zululand, Natal. He announced recently that he hoped to make arrangements to have the area thoroughly prospected. Viljoen announced that tenderers will have to give guarantees designed to prevent prospecting "for speculative purposes." The Department of Mines is making its own surveys of the area in the meantime.

Sinclair Completes Well In Julesburg Basin

Sinclair Oil and Gas Company has completed a new well in Logan County, Colorado at its No. 1 Duncan. It is Sinclair's first well in the Julesburg basin. The well flowed 100 bbl of 35.4 deg gravity oil in six hours from 5222 to 5228 ft. It is about 10 miles west of Sterling, Colorado.

Sun Stakes Deep Oil Test

In Crockett County, Texas, Sun Oil Company is drilling what may be the deepest exploratory well in Texas. The well, which is Sun's No. 1 Mrs. Myrtle Mitchell, is set for 15,000 ft—400 ft into the Ellenburger. Present depth record is held by Phillips Petroleum Company, at its No. 1 Ada Price in Pecos County. It was abandoned as a dry hole at a depth of 15,279 ft.

Warren Oil Well Completed

Warren Oil Company has completed its Nash-Daniels unit No. 1 in Young County, Texas. Drilled to a total depth of 4406 ft, gas reached the surface in 3 minutes and oil in 8 minutes on a drillstem test of 21 minutes. Production is from the Mississippi lime. Eight barrels of oil were recovered in the drill pipe. Bottom hole pressure registered 2050 lb in 20 minutes.

New Texas Field Opened

The Texas Company announced the opening of a new field 17½ miles north of Palestine, Texas, in Anderson County with the completion of the C. W. Hanks No. 1 as a distillate-gas producer.

Perforated from 10,090 ft to 10,104 ft, the wildcat flowed at the rate of 270 bbl of 55.2 gravity distillate and 2,000,000 cu ft of gas per day on a 10-hour test through 11/64-in. choke with tubing pressure of 3700 lb. The gas-oil ratio was 7400 to 1. The test was drilled to a total depth of 10,758 feet.

Devonian Field Opened In Lea, New Mexico

Amerada Petroleum Corporation has completed its No. 1 States ECA in Lea County, New Mexico, opening a new Devonian field. The new producer was completed for a daily flowing potential of 550 bbl of oil daily through a ½-in. choke through perforations at 11,260-11,270 ft. Gas-oil ratio was 20 to 1.

Bishop Drills Texas Well

Bishop Oil Company announced that it has brought in a new well in Coleman County, Texas, flowing at the rate of 10 bbl of 44 gravity oil per hour. It was drilled to a total depth of 3371 ft. The well is the Davis No. 1.

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Webster Parish Field Opened by Skelly

A new oil field has been opened in Webster Parish, Northern Louisiana, two miles east of the Bellevue field. The new field opener is Skelly Oil Company's No. 1 E. L. Stewart, which is waiting for potential rating. Tests made through ¾-in. choke flowed 321.62 bbl of oil in six hours from a depth of 4006-09 ft and 184.82 bbl of oil in 4 hours.

South Dakota Test Is Set for Devonian Sand

Shell Oil Company's rank wildcat in Perkins County, northwestern South Dakota has been drilled to about 6100 ft. The Schlumberger is being run to identify definitely the formations encountered, and the top of the Sundance has been checked at 4520 ft. Operators plan to drill to the Devonian about 9000 ft, unless commercial production is found at a shallower depth.

Sun Stakes 12,500 Ft Test

Sun Oil Company has announced plans for a 12,500 ft wildcat test three and a half miles south of the Wilson Creek area of Matagorda County, Texas. It will be the company's No. 1 G. B. McKissick.

Colorado Wildcat Will Open Exploratory Area

A new Dakota sand field has been opened in Adams County, Colorado at Noble C. Ginther, Howard C. Warren, and Wilbur L. Ginther's No. 1 Noonan. The new well is swabbing at the rate of 3 bbl of oil an hour from 6192 to 6245 ft. The new discovery is 40 miles from the nearest discovery, and will open a vast new area for exploration.

Largest Canadian Gas Well Is Scene of New Oil Strike

Oil has been struck in the same well Albercan Oil Corporation drilled as Sasketchewan's, Canada's largest gas well recently. At 400 ft below the gas-producing zone, an estimated 150 to 200 bbl daily of oil has been found. Production is from a 66-ft interval of the Sparky sand encountered at 2684 ft. J. H. Brockelbank, Sasketchewan's minister of natural resources, stated that the original purpose was to test all sections down through the Devonian, major producing zone of the Leduc and Red Water fields, but that operators had decided to complete the well in the Sparkey rather than jeopardize the producing formation with further drilling.

Continental Opens New Wyoming Oil Field

With completion of its No. 1 West Sussex Unit, Continental Oil Company has opened a new oil field in Johnson County, Wyoming. The new well, which flowed through a ¼-in. choke on test, flowed at the rate of 216 bbl of oil a day from the Shannon sand at 2850-2950 ft. It was drilled to 6160 ft to test the Dakota, but was plugged back.

Phillips' New Mexico Well Completed at 12,632 Ft

Phillips Petroleum Company has a new oil well in Lea County, New Mexico at its No. 1 Fort. The new well recovered 33 bbl of 45.1 gravity oil following a 2-hour drillstem test at 12,582-12,632 ft. The drillstem test covered the top 50 ft of the Devonian section. The new well is one mile from present production in the Denton field of Lea County.

Fourth of Ten Tests Made In Northern Peru Area

A year ago last April, Dunlap and Graham Drilling Company, Inc., drilling contractors of Long Beach, California, entered into an agreement with Empresa Fiscal Petroleo to drill 10 exploratory wells, each to an approximate depth of 9000 ft, in Northern Peru. A division office was set up in Lima, with W. J. "Swede" Larson, vice president in charge, and a field headquarters was established at Zorritos.

Meantime, according to D. H. Graham, president of the Dunlap and Graham organization, drilling has progressed very satisfactorily although no production has yet been obtained. Three dry holes have been drilled to the required depth, and the rig is now operating on a fourth try. Dunlap and Graham officials have been exceptionally pleased with the fine co-operation extended to them by Ing. Artidoro Alvarado Garrido, director of petroleum for the Peruvian Government, and by the officers and staff of Empresa Fiscal Petroleo.

Klaus Makes Survey Of North Texas Area

A detailed gravitymeter and magnetometer survey is being made for H. S. Jondahl, in north central Collingsworth County, Texas by Klaus Exploration Company of Lubbock. Survey is being made in the Quail area of Collingsworth County, straddling the Salt Fork of Red River.

Klaus Exploration reports that the area is very rough, cut by many gullies and sink-holes, and covered by the Double Mountain and Custer formations of the Permian system. Fourwheel drive equipment is essential south of the river, as there is much sand dune and the ground is extremely rough.

This area is practically virgin territory, Klaus reports, as no deep holes have been drilled with the exception of the recent Superior test, which is reported to have reached granite at or near 5800 ft after encountering good shows of gas in the section above. The Klaus exploratory area is somewhat farther down the flank of the Amarillo Uplift, or the Panhandle oil and gas field, and should encounter the granite at a greater depth than the Superior well. There exists a distinct possibility of lower Pennsylvanian or pre-Pennsylvanian formations coming below the main unconformity of the area.

Oklahoma Wildcat Has Good Oil Indications

Newest discovery in western Oklahoma is Sinclair Oil and Gas Company's rank wildcat in Major County. The new well is the company's No. 1 Campbell, which had good shows on a drillstem test in the Mississippi between 7393 ft and 7415 ft. Tool was open 90 minutes, and gas appeared in 30 minutes at 220,000 cu ft daily. Three hundred feet of oil and heavily gas-cut mud were recovered.

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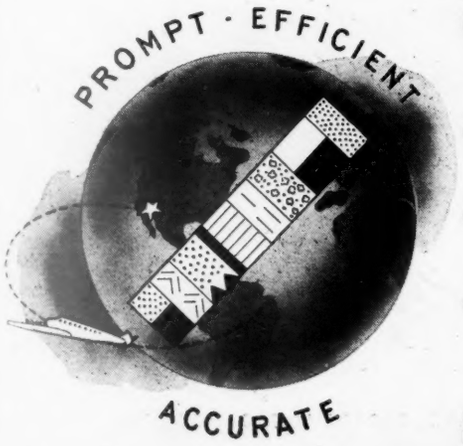

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Joint Meeting of Exploration Societies

The Pacific Sections of the American Association of Petroleum Geologists, Society of Exploration Geophysicists, and Society of Economic Paleontologists and Mineralogists will hold their 28th annual joint meeting Nov. 1 and 2 at the Ambassador Hotel, Los Angeles.

AAPG tentative program will feature the following papers: The Huasna Basin, Gordon Bell; Elk Hills, John Wells; Belgian Anticline, C. W. Porter; Santa Cruz-Halfmoon Bay, Tom Baldwin; A Philosophy of Oil Finding, Wallace E. Pratt; Historical Background of the Geology of the Castaic-Newhall Basin, W. S. W. Kew; Discussion of the "Modelo" Sandstone Unit of the Northern Slope of the Santa Susana Mountains, E. L. Winterer; Newhall-Castaic Basin, J. W. Sheller; Castaic Junction Field, Hunter Yarborough; Honor Rancho Field, F. D. Bode and A. J. MacMillan, L. A. Basin Cross Section, R. T. White; Salinas Valley Cross Section, J. E. Kilkenny and Southern San Joaquin Valley Cross Section, Paul McGovney.

SEG papers are as follows: Isochron Interpretation Technique, Dr. E. D. Alcock; Effect of High Explosives on Fish, Dr. Hubbs; Frequency Analysis of Seismic Waves, Dr. J. J. Jakosky; Review of Brussel's Meeting of the International Union, Dr. C. H. Dix, and papers on California Research and Gravity (titles to be announced).

The joint session will be held Nov. 2. Papers to be given are: San Fernando-Lopez Canyon-Hazel Canyon-Tujunga Canyon Area, Gordon Oakeshott; Geology of the Tecolote Tunnel, Robert Trefzger; Helm Field with Reference to Seismic Case Histories and Discovery Methods, Curtis Johnson, and Dinuba Area, Milton Boran.

AAPG Group to Meet

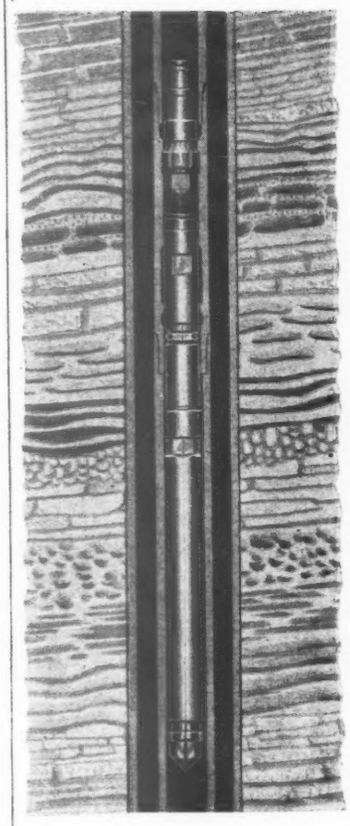
The Rocky Mountain section of the American Association of Petroleum Geologists will be held in Salt Lake City, Utah next February 28 and 29. Theme of the meeting will be, "Are conspicuous formational irregularities in the Cordilleran Geosyncline better explained by large-scale thrust faulting or by abrupt facies changes?"

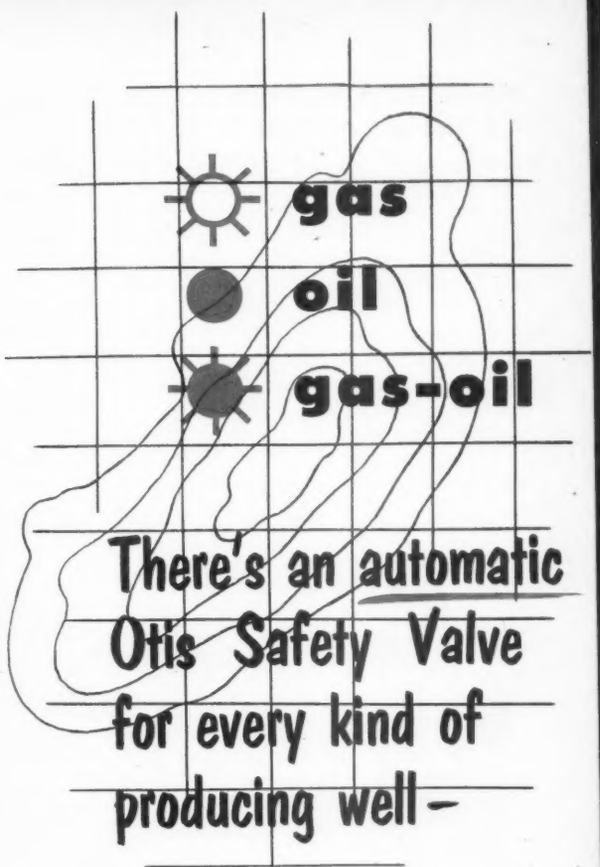
British American Opens New Canada Field

British American Oil Company, Ltd., has located a new discovery in Alberta, Canada, about 15 miles south and west of the Leduc field.

The discovery had the D-3 Devonshire lime at 6179 ft and cored to 6189 ft. With the tool open one hour on drill stem test, gas showed in three minutes, oil in 18 minutes, without gage being made. Recovery was 1200 ft of clean 38 gravity oil.

The discovery is 5 miles north of the Wizard Lake discovery of Texas Company. British American owns lease on between 1200 and 1500 acres around the discovery.





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Pemex Buys Properties Of Sinclair Affiliate

Officials of Sinclair Oil Corporation and Petroleos Mexicanos (Pemex) have worked out negotiations whereby El Charro Oil Company, Mexican affiliate of Sinclair, has sold all its oil lands to the Mexican government-owned oil company. No money will be received for the properties, however, unless oil production is successful. The deal covers approximately 750,000 acres of oil concessions in the Texas-Mexico border state of Tamaulipas.

El Charro will receive $1,852,000 to be paid from sale of 20 per cent of any oil or gas discovered on the lands of Pemex drilling, after production begins. Pemex will get title to the lands and drilling concessions plus all drilling information about them.

Pemex also bought all rights held in the area by Rio Bravo Exploration Company for $48,000 to be paid within six months.

Geophysical Company Formed

The Continental Geophysical Company has completed its organizational plans and is in active operation, A. E. "Sandy" McKay, president, has announced. Offices are at 6100 Camp Bowie Boulevard, Fort Worth, Texas.

A. E. McKay

Continental Geophysical Company will supply contract seismograph crews to the industry, act as consultants on exploration problems and engage in reanalysis of geophysical data.

McKay is a graduate of Oklahoma University and was employed by the Indian Territory Illuminating Oil Company in Bartlesville as a geologist and geophysicist for nine years.

Later he became assistant chief geophysicist for the Atlantic Refining Company. In June 1950 he accepted the executive vice presidency of the Southern Geophysical Company.

McKay's exploration experiences have extended from Canada to Alabama, including a great deal of geophysical work in the Mid-Continent and Rocky Mountain states. He has been active in the discovery of many fields in these areas.

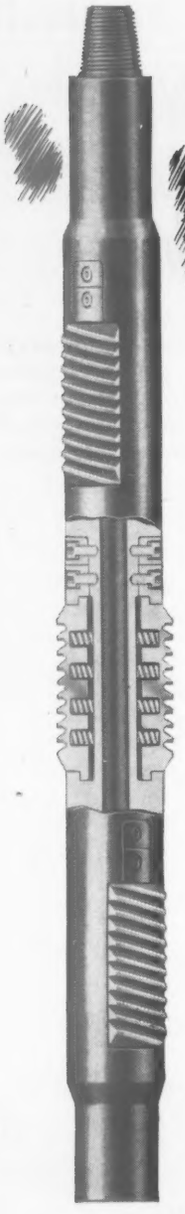
Phillips Plans Large Oil Exploration Program

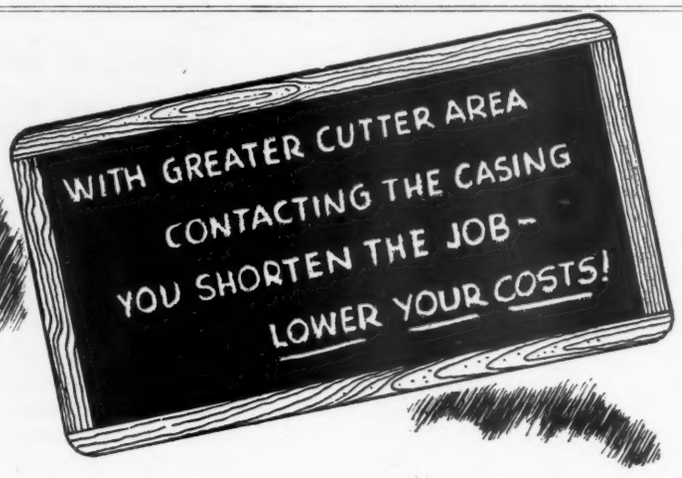
Phillips Petroleum Company owns oil and gas leases on 1,843,400 net acres in the active Williston Basin of North Dakota, South Dakota, and Montana. Of the total, 981,800 acres are situated in North Dakota, 400,000 acres in South Dakota, and 461,600 acres in Montana.

On the Nesson Anticline in North Dakota, on which Amerada's two recent discovery wells are situated, Phillips owns leases covering 5300 net acres. The company holds 145,000 net acres of leases within 50 miles of these two wells.

In Roosevelt County, Montana, in the western part of the Williston Basin, Phillips and associates have staked location for an 8500 ft Devonian test. This well will be situated on a 34,143-acre Federal Unit in which Phillips owns a 16.2 per cent interest. In the same county Phillips and associates are preparing to deepen their No. 1 West Poplar Dome, formerly bottomed at 5051 ft, to a depth of 9000 ft to test the Devonian. A 47.4 per cent interest is owned by Phillips in this 24,040-acre Federal Unit. Within six miles of these two units the company owns an additional 29,680 net acres.

In another area of particular interest at this time, the prolific Spraberry sand trend of West Texas, Phillips owns oil and gas leases on approximately 30,000 net acres. An aggressive program is now underway to develop this acreage.





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Cable Tool Underreamers	27
Hole Enlargers	38
Reamers	43
Hydrostatic Perforation Cleaners	50
Dump Bailers	51
Roller Cutter Shale Bits	54
Sand Pumps	55
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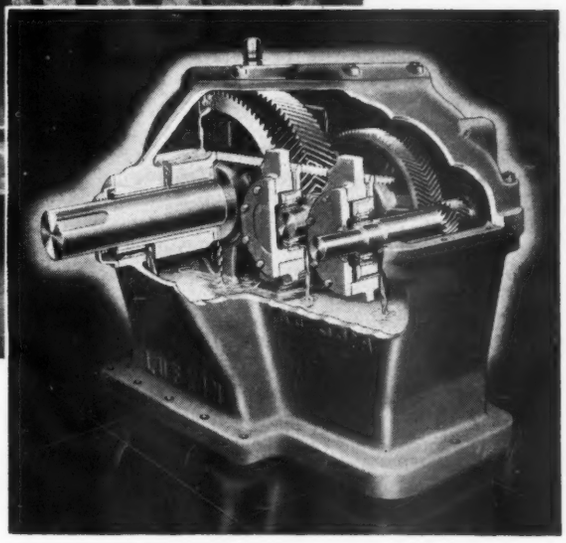

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Machinery and equipment produced by leading manufacturers for use throughout the oil field are Hyatt-equipped and have been for many years. The dependable performance of Hyatts is in no small way due to the precision and the year-after-year durability built into them. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

Running tour with men in the industry

E. L. DeGolyer

E. L. DeGolyer, internationally known geologist, has been accorded an honorary doctor's degree from the 400-year-old University of Mexico. The honor followed his recent election to honorary membership of the American Institute of Mining and Metallurgical Engineers, an office which only 20 men may hold at any one time.

Dr. DeGolyer, who has spent the greater part of his 65 years in the discovering of oil producing areas of the Western Hemisphere, has located producing wells in most of the important areas of the hemisphere.

In 1909, when he was but 23 years old, he located the famous Potrero del Llano No. 4 in Mexico. This "find" has alone produced in excess of 100 million barrels of oil. In 1919 he organized the Amerada Petroleum Corporation and in 1925 its subsidiary, the Geophysical Research Corporation. He served for a number of years as president of the two firms as well as chairman of the board of the former.

In 1914 he became a member of the Petroleum Division of AIME where he has served as chairman of the Petroleum Division, as president of the Institute, and a director. He has served on various committees of the Institute throughout his membership.

The United States Government has solicited his advice and service during a number of times of emergency. He is a charter member of the National Petroleum Council, the Military Petroleum Advisory Board and the Advisory Committee on Raw Materials of the Atomic Energy Commission. Dr. DeGolyer is still active in the present accelerated search for new petroleum reserves as head of the geological and engineering consulting firm of DeGolyer and MacNaughton.

W. D. C. Mackenzie, assistant manager of Imperial Oil's western producing division for the past three years, has been appointed manager of the division. He succeeds **R. B. Curran,** who has resigned.

Mackenzie was born in Macleod, Alta. He graduated from the University of Alberta in 1935 with a B.Sc. degree in mining engineering and the following year joined Imperial's geological department at Calgary. In 1937 he took charge of sub-surface geological work in the Turner Valley field and later was transferred to the petroleum engineering department there. In 1942 he joined the Canol project working with the U. S. government. After the war he became chief engineer of the company's producing department and in 1948 was appointed assistant manager of the western producing division.

E. D. Loughney has been appointed general manager of Canadian Gulf Oil Company. He will make his headquarters at Calgary, Alberta, Canada. Loughney was a former assistant to the vice president. He succeeds John H. Bevel, who resigned.

J. H. Menke

J. H. Menke has retired from his position with Standard of California after 35 years of service. He was assistant chief petroleum engineer, San Francisco, California, producing department. A graduate of Stanford University, Menke joined Pacific Oil Company as assistant to the geologist in 1916. He later became resident geologist, geologist, and at the time of the merger of the Pacific Oil Company with Standard (California) in 1926, he was transferred to Taft, California, as district petroleum engineer on development and production engineering. He transferred to the San Francisco office to the position of assistant chief petroleum engineer for the San Francisco area in 1932, a position he held at the time of his retirement. Menke was recently honored at an informal dinner in Los Angeles, California.

Edward C. Cram

Edward C. Cram, former regional geologist at Dallas, Texas, for Magnolia Petroleum Company, has been transferred to the New York office of Socony-Vacuum Oil Company, Inc., as coordinator of domestic production. Cram was president of the Petroleum Engineers Club of Dallas for 1951. **Wayne R. Hammond** has been promoted to the position occupied by Cram.

C. I. Alexander, who has been district geologist at San Antonio will be transferred to Dallas as a regional exploration geologist. **Joseph Neely,** district geologist in Shreveport, Louisiana, has been transferred to Tyler as district geologist in charge of the East Texas district. **Kenneth F. Keller,** geologist in San Antonio will be promoted to district geologist at Shreveport.

Howard M. Walker has been promoted to Magnolia Petroleum Company's general offices in Dallas as assistant general superintendent of the producing division.

Wade G. Moriarty was promoted to assistant division superintendent of Magnolia's Gulf Coast division from district superintendent of the company's Brownfield district in West Texas.

John R. Hissom has been promoted to district superintendent of the Brownfield district. He was formerly assistant district superintendent of that district.

Joseph M. McLaughlin was promoted to assistant district superintendent of the Brownfield district from production foreman in the same district.

John S. Goodrich was promoted to assistant district superintendent of Magnolia's Kermit district from production foreman in the Kermit district.

Horace Gale Brelsford, former senior petroleum engineering assistant in Magnolia's Kermit producing district, was transferred to the producing division as production foreman in the Kermit district.

Garland C. Rutherford, assistant foreman in Magnolia's Falfurrias producing district, was promoted to production foreman in the Snyder area of the Brownfield producing district.

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Featuring Accurate Logging of THIN Beds with a NEW METHOD of Detecting Radioactvity!

Accurate logging of even the THINNEST beds in your well is now possible, This means that beds from 12 feet down to one foot and even less, can be accurately located and logged for the first time!

Sharp logs with high peaks, more breaks, straighter sides, greater definition, and more definite markers have been produced with the new McCullough Radiation Well Logger. Some of the most difficult zones in Texas and California have been logged with outstanding results in the last 12 months. New, thin producing zones have been located—zones that had formerly been missed completely! These logs by actual comparison, are SHARPER than an S.P. or Resistivity log, although made through several strings of casing!

All this is made possible by the use of a radically NEW METHOD of detecting radioactivity—the McCullough Scintillometer.

McCULLOUGH SCINTILLOMETER

It was formerly thought impossible to decrease the length of the counter and at the same time increase its sensitivity. It has been acknowledged that IF such a counter could be developed, a sharper, more accurate log would result.

In order to get such results it was necessary to depart from usual methods of detecting gamma ray radiation. The counter in the new McCullough Radiation Well Logger is the McCullough Scintillometer—a solid counter. Because of its high density it is capable of detecting practically ALL gamma rays striking it. It is shorter in length than the radius of any hole it may be run in, yet it is a great many times MORE sensitive than any counter of equal length.

The McCullough Scintillometer is not electrically excited. Measurements made are independent of electrical leakage and only radioactivity is measured.

This extremely small counter permits logging even the THINEST beds at their TRUE radioactive level. Base of the break on the log IS the base of the bed—thick or thin.

The supersensitivity of the McCullough Scintillometer permits considerably greater detail in the completed log, since:

1. Its efficiency is close to 100%.
2. It is equally sensitive to high and low energies, yet it does not record meaningless counts (No background radiation).
3. The high count rate, increased running speed, and decreased time constant gives less drag or lag at formation edges.

AVAILABILITY

The McCullough Radiation Well Logger is now available in Texas and California. Other instruments are in production and will be made available in all other areas as fast as we can obtain necessary supplies and equipment. Contact the McCullough Service Engineer in your locality for latest information.

EASIER, MORE ACCURATE INTERPRETATION BECAUSE:

1. Thin beds are logged at their TRUE radioactive level.
2. A greater detailed log athough run two to three times faster.
3. Curves produced contain more breaks, greater definition, more definite markers.
4. Original log is sharper than an S.P. or Resistivity log.
5. Original log DOES NOT need retouching or redrawing.
6. It is calibrated in International Units permitting quantitative measurements of radioactive radiation.
7. Since it has no instrument or temperature drift, it can be used as a future reference tool.
8. It records an extremely broad band of radiation waves, and only part of the band can be measured if desired.
9. It has located new producing zones where other methods had failed to record.
10. Only radioactivity is measured.
11. It does not record meaningless counts (no background radiation).
12. Collar log made simultaneously.
13. Correlates more accurately with electric logs.
14. Counter is not energized by electrical power, eliminating unknown counts due to electrical leakage.

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To obtain more information on products advertised see page E-53

▸ **Thomas A. Atkinson** has been named assistant manager of Rocky Mountain operations for the General Petroleum Corporation's production department. In his new post Atkinson will be situated in Casper, Wyoming, where General Petroleum production operations are headed by **A. F. Barrett.**

Edward S. Hochuli will replace Atkinson in the latter's most recent assignment with General Petroleum. Hochuli becomes manager of the corporation's industrial relations department. He will be in Los Angeles.

Atkinson first worked for General Petroleum as a high school boy in 1926. He held intermittent jobs with the company while attending the University of California from which he received a mechanical engineering degree in 1933.

Hochuli joined General Petroleum in 1946. Also a graduate of the University of California in mechanical engineering, Hochuli spent 2 years as an engineering consultant with a naval engineering concern.

▸ **Jim Tooley** will serve as assistant to the president of Ferrell Drilling Company, with headquarters at Great Bend, Kansas.

▸ **Carl G. Holt** will serve as drilling and producing engineer for the Wheless Drilling Company, Shreveport. Holt was formerly with The California Company as petroleum engineer.

L. C. Decius

▸ **L. C. Decius,** vice president, Tide Water Associated Oil Company, has retired.

Decius, widely known in oil circles, has been in the service of Tide Water Associated and its former subsidiary, Associated Oil Company, for more than 35 years, and at the time of his retirement, occupied the position of vice president and director of exploration of the company's Western division. All land, geological, and exploratory activities of the company in California, the Rocky Mountain area, and Canada were under Decius' jurisdiction. Decius received his degree in geology from Stanford University.

▸ **J. Kenneth Barton,** chief engineer in charge of water-flooding for Quaker State Oil Refining Corporation's production department at Bradford, Pennsylvania, has been appointed a member of the Pennsylvania Grade Crude Oil Association's production research technical advisory committee.

Barton discovered and developed the so-called slug treatment of oil properties with sodium hypochlorite and has helped pioneer the use of amine-type chemicals for treatment of water injected under high pressures into oil formations. Beginning in the oil fields as a pumper and roustabout, he became lease foreman for Forest Oil Corporation. Later he did scouting, engineering, and geological work for the firm in Pennsylvania, Illinois, Ohio, and West Virginia.

▸ **MacDonald Oliver, Jr.,** has been named chief engineer for San Juan Oil Company, Dallas, Texas. Oliver is a graduate petroleum engineer from Texas A. & M., and was formerly with the consulting engineering firm of Cable and Stine, Wichita Falls, Texas.

V. B. (Buddy) Harris, has been named chief production engineer. Also a graduate of Texas A. & M., Harris was formerly employed by Barnsdall Oil Company, Core Laboratories, and Harper-Turner. **Harold Eugene Wright** has been named production engineer. Wright is a graduate engineer from Texas Technological College, and was formerly district engineer, West Texas district, Hiawatha Oil and Gas Company. **R. W. Russell,** a graduate of Texas A. & M., was exploitation engineer for Shell Oil Company before joining San Juan Oil Company.

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IF EACH OF US WOULD . . .

. . . inform our elected representatives of our personal opinions on each issue before Congress

. . . when proposing constructive government action, make no exceptions for our own special advantage

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. . . take the trouble to vote on election-day morning, instead of making pretty speeches beforehand, then by-passing the polls for the golf course

. . . WE WOULD HAVE SUCH A CONCENTRATED POWER THAT COMMUNISM, SOCIALISM AND ALL THE OTHER CRACKPOT "SOMETHING FOR NOTHING" SCHEMES WOULD DISSOLVE INTO THE EMPTINESS THEY REALLY ARE!

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for

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SPECIFY SPANG—FOR SALE BY DEALERS EVERYWHERE

For Economical Pumping in Any Type of Well

Maybe your pumping is limited to medium duty in mild wells: Or perhaps it covers a broader range, including heavy pumping in corrosive wells. In either case, you can rely on Bethlehem Sucker Rods for economy and all-around dependability.

Bethlehem Sucker Rods are economical and dependable because they are made by precision methods from quality steel. In the normalizing operation, a special device for rapidly transferring each rod from the furnace to the cooling bed insures a completely normalized rod. This normalized structure, and the resulting mechanical strength, helps to keep strings in the hole, thus minimizing down-time.

Bethlehem Sucker Rods come in a specially designed unit package, with individual rods protected during shipment, so as to reach you in first-class condition. There's no kinking. No lost time in handling at the yard.

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BETHLEHEM, PA.

BETHLEHEM *Sucker Rods*

BETHLEHEM STEEL

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THE WORKING COMBINATION

of Axelson Deep Well Pump Plungers and Axelson Duax Pump Liners delivers more oil at less lifting cost with less down time . . . proved in Axelson's almost 60 years of service to the petroleum industry.

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Van Thompson N. P. Chesnutt

Van Thompson has been appointed manager of the newly created exploration department, Southern Union Gas Company, and **N. P. Chesnutt** has been named chief engineer.

The two men have long years of service with Southern Union, a natural gas utility with headquarters in Dallas, serving sections of Texas, New Mexico, Colorado and Arizona.

Thompson joined Southern Union in 1929, and has had wide experience in the actual operations of the company. He worked in construction and engineering in Colorado and New Mexico, taking part in and helping direct the company's initiation of natural gas service to New Mexico cities and communities. Thompson was transferred to Dallas as engineer and superintendent of gas measurement in 1938 and became head of the engineering department in 1945.

Chesnutt joined Southern Union in 1935, immediately after graduation from the University of Oklahoma School of Engineering. He worked in the company's West Texas properties and was West Texas district engineer in 1941 when he entered the U. S. Army.

Prior to his promotion to chief engineer in charge of the engineering department, Chesnutt since 1948 has been in the Dallas office, doing research and supervisory work on special projects and assisting in general activities of the engineering department.

Lee C. Lamar Merrill W. Haas

Appointment of **Merrill W. Haas** as chief geologist and **Lee C. Lamar** as assistant chief geologist for The Carter Oil Company, effective immediately, was announced recently by H. F. Moses, Tulsa, vice president in charge of exploration and research.

Haas, a native of Albert, Kansas, has been with Standard Oil Company (New Jersey) and affiliates 17 years and recently has been staff geologist with Carter in Tulsa. He finished elementary schooling in Great Bend, Kansas, and did college and graduate work at the University of Kansas, University of Michigan and Harvard University. He has served as research paleontologist for Humble Oil and Refining Company, chief paleontologist for the Standard Oil Company of Venezuela and division geologist for Creole Petroleum Corporation.

Lamar began work with Carter in 1932 following graduation from the University of Oklahoma. He was district geologist and land man in Michigan, transferred to Mattoon, Illinois, as division geologist and since 1947 has been on Carter's geological staff in Tulsa. He is a native of Tulsa, Oklahoma.

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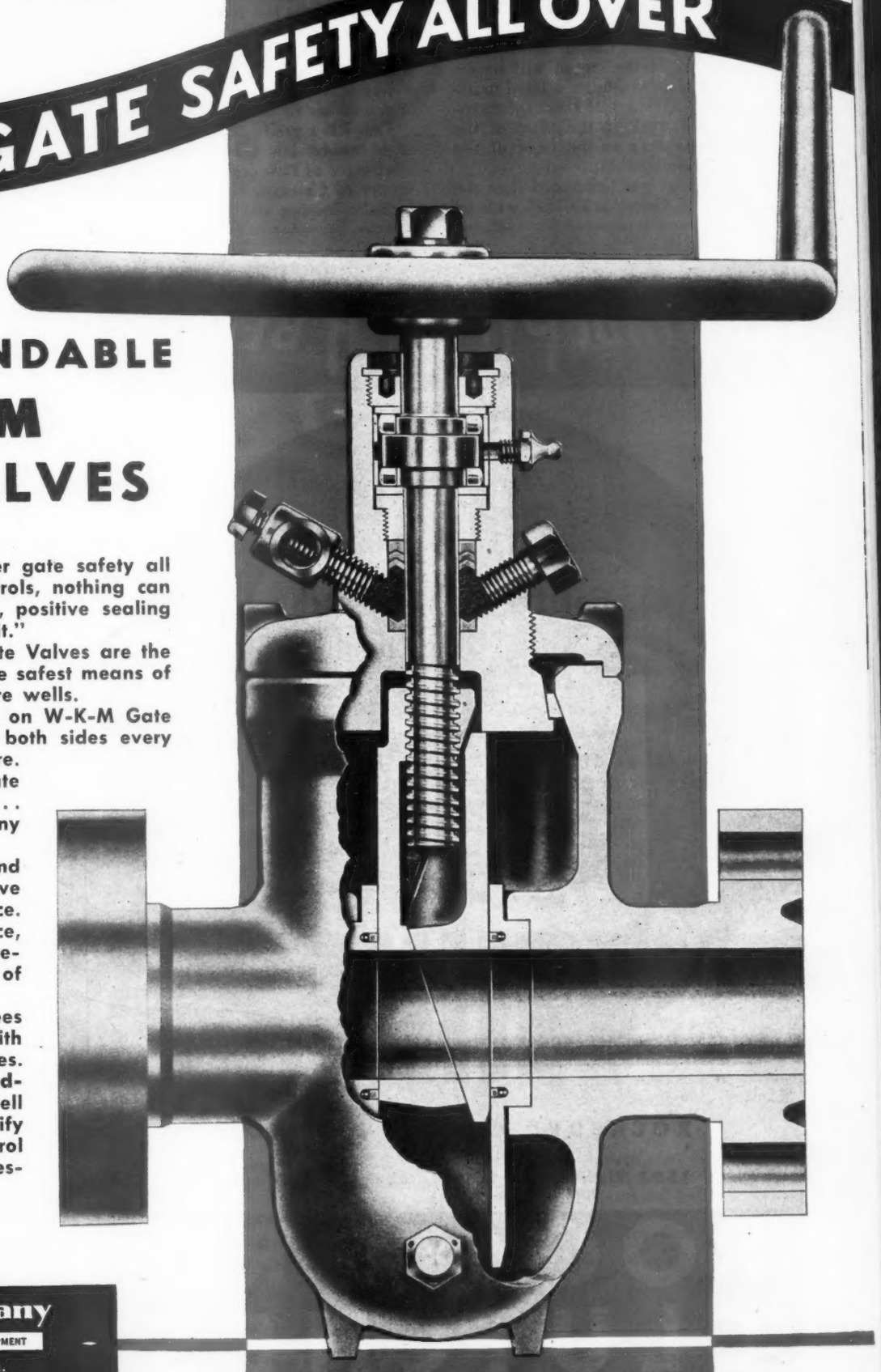
WITH DEPENDABLE W-K-M GATE VALVES



If you suddenly need master gate safety all over your Christmas Tree controls, nothing can take the place of dependable, positive sealing valves. "Gadgets" can't "cut it."

In the long run, W-K-M Gate Valves are the most economical and by far the safest means of controlling high or low pressure wells.

For safety, you can depend on W-K-M Gate Valves to seal completely on both sides every time against full rated pressure. You can be sure that W-K-M Gate Valves will not bind or freeze . . . will open or close easier than any other valve.

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So give your Christmas Trees master-gate safety all over with dependable W-K-M Gate Valves. They are safety insurance...additional insurance that your well is always under control. Specify W-K-M Valves. They now control more than 80% of all high pressure wells in the world.

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R. M. Davant, district landman for Pan American Production, will be in charge of that company's new offices at Shreveport, Louisiana. The company moved its location from Jackson, Mississippi.

George Hetherington has been appointed staff reservoir engineer in the Pittsburgh office of the production department, Gulf Oil Corporation. In his new position, Hetherington will be engaged in technical studies related to improving the efficiency of crude oil recovery. He will work in the office of the technical assistant to the head of the production department.

Hetherington was graduated from the University of Colorado in 1928 with an AB degree. He also did graduate work at the University of Oklahoma and the Colorado School of Mines. He joined Gulf in 1945 as staff reservoir engineer at Los Angeles.

Dr. Walter J. Fenny of Winnipeg, Manitoba, has joined Deep Rock Oil Corporation as the representative of its land and exploration division in Calgary, Alberta. After a short indoctrination period in Deep Rock's Tulsa office, Fenny will be stationed in Calgary. He is a member of the Manitoba Bar.

Fenny is a graduate of the University of Manitoba law school, and received his Doctor of Law degree from the University of Chicago. His oil background includes leasing and title experience.

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ROCKFORD CLUTCHES

Dewey A. Jordan

Dewey A. Jordan, who has been general production superintendent for The Atlantic Refining Company, began his new duties as general superintendent, October 1 for the firm of Edwin B. and Edwin L. Cox of Dallas, Texas.

Jordan is a past president of the Dallas Petroleum Engineers' Club, and is vice chairman of the Southwest District Technical Advisory Committee on Vocational Training for the American Petroleum Institute.

Henry J. Tyler, division staff geologist for Phillips Petroleum, Bartlesville, has been transferred to Shreveport as district geologist. He succeeds R. H. Chambers, who resigned to become an independent.

Hudie H. Barber has been promoted from assistant foreman to production foreman in the Jackson, Mississippi, area of Magnolia Petroleum Company's Shreveport, Louisiana, producing district.

Howard W. Shields, assistant foreman in the Salem, Illinois, producing district, has been transferred to the Electra, Texas, district and promoted to production foreman.

Adolph Sieker, who was formerly assistant foreman in Magnolia Petroleum Company's Chase, Kansas producing district, has been promoted to production foreman and transferred to the company's Brownfield, Texas, district.

Wm. L. McDonald, Jr., petroleum engineer at Magnolia's Morgan City, Louisiana producing district, has been transferred to the Kermit producing district with headquarters at Kermit, Texas.

Charles C. Baker, senior petroleum engineering assistant, has been moved from the Eldorado, Kansas, district to the Kermit producing district.

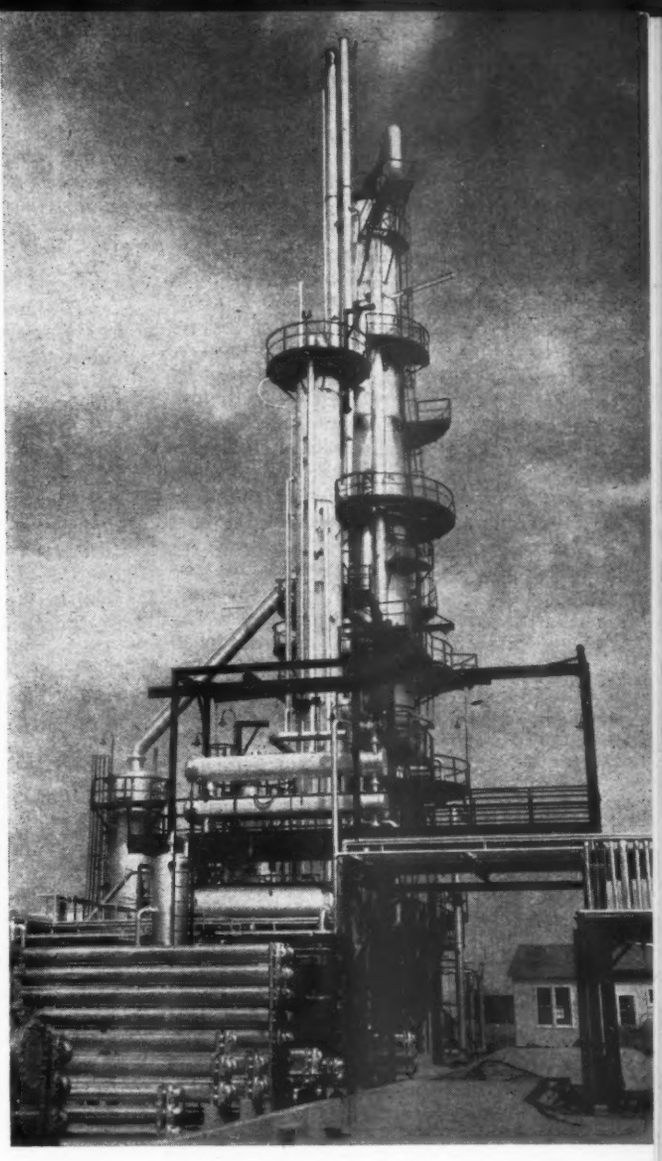
Lee A. Keeling, who was formerly petroleum engineer at Kermit, has been moved to the Eldorado district with headquarters there.

Archie W. Brown has been promoted from district schedule man in the Rusk district to field foreman in the Pegasus area of the Kermit natural gas field.

Appointment of **Wallace B. Quail,** of Middleton, Ohio, as Director of the Iron and Steel Division, National Production Authority, U. S. Department of Commerce, was announced by NPA Administrator Manly Fleischmann.

Chemists Survey Oil Refining Technology

ARCH L. FOSTER*



New Fluid catalytic cracking unit operating at Panhandle Refining Company's plant at Wichita Falls, Texas, is typical of the inroads catalysis has made in petroleum refining.

THE petroleum industry is spending this year more than one hundred million dollars ($100,000,000) on research alone, one-fourth of the total research expenditures of the entire country's industry. This sum is five times the amount spent for research in 1940, but due to inflated costs, this does not represent a five-fold increase in the amount of research, stated R. E. Wilson, board chairman of Standard of Indiana. He spoke before representatives of the 2000-member Petroleum Division, American Chemical Society, in huge conclave in New York City early in September.

Adverse government action toward research expenditures, or Federal dismemberment of the large companies responsible mainly for the greatest part of this research are among the relatively few discouraging factors that might stop the still upward trend of research. Improved techniques in pilot plant operation, and the determination and compilation of vast amounts of data on hydrocarbons and mixtures of hydrocarbons have given the present-day technologist tools by which he can foretell the probable behavior of a given material, and design on an intelligent basis large-scale equipment of every sort, Wilson stated.

The second outstanding achievement of the 20th century's second quarter is that of the "catalytic revolution." Of 32 papers in the New York Symposium, 15 dealt with catalysis and catalysts. Wilson estimates that 60 per cent of the gasoline made in the USA is composed of "new" molecules not present as such in the original crude. Other influences include cooperative research and greater scope in research efforts. Production of entirely new products, synthesis of hydrocarbons and petrochemicals are increasing rapidly the outlets and demand for petroleum.

Olefin Polymerization

Polymerization of olefins, too high in volatility to make proper ingredients for motor fuels, to form lower volatility hydrocarbons in the gasoline boiling range has done much to increase the octane rating of finished fuels and to produce more motor fuel than could have been done otherwise. Both thermal and catalytic processes have been developed, the thermal process first, by Phillips Petroleum Company and by Pure Oil Company independently; nowadays thermal polymerization reactions are included with thermal reforming in processes like the so-called Polyform Process. Two catalytic processes, using phosphoric and sulfuric acids, respectively have been applied more widely, say P. A. Maschwitz and L. M. Henderson of Pure Oil. These both employ lower temperatures and pressures than does thermal reforming. Shell Oil Company developed the hot and cold sulfuric acid processes; Universal Oil Products Company developed the phosphoric acid process, of which more than 150 units have been licensed so far, and Kellogg brought out a pyrophosphate process. Present-day chamber type units operate at 500 psig and 350-400 F inlet, 450-475 F outlet temperatures to obtain 85-95 per cent olefin polymerization. Higher conversions can be obtained but only at the expense of more catalyst and shorter catalyst life. A peculiar item in the process is the necessity of having a certain amount of water vapor in the reaction system.

The polymerization mechanism has been explained by several theories. Pressure favors the polymerization reaction; two of the most outstanding theories are those by Ipatieff and by Whitmore. Ipatieff stated earlier that he believes polymerization occurs by reaction between two molecules of the ester formed by the acid and the olefin, which combines the two olefin radicals to form a larger molecule, and regenerates the acid. Whitmore's carbonium theory assumes the formation of a larger carbonium ion by the addition of a positive hydrocarbon (carbonium) ion to an olefin, and then the elimination of a proton to yield the polymer. With an acid catalyst the original carbonium is formed by adding a hydrogen ion from the acid to the extra electron pair in the olefin double bond. By using deuterium tracer atoms in a polymerization reaction, Farkas and Farkas have proposed a modification of Ipatieff's theory, which is not considered 'conclusive' at present, but the method offers a good strategy for attacking the problem, the authors believe.

Reformer Catalyst

Modification of the conditions and properties of a strong isomerizing catalyst, which also originally proved a strong cracking catalyst at aromatic-forming temperatures, has yielded one that reforms naphthas satisfactorily, say M. J. Fowle, R. D. Bent, F. G.

*Editor, Refining and Gas Processing.

EXCLUSIVE

Ciapetta, P. M. Pitts and L. N. Leum of Atlantic Refining Company's research staff. This catalyst contains a hydrogenation catalyst—platinum—dispersed on a silica-alumina carrier, which is also a strong cracking catalyst. As the catalyst showed too much cracking of paraffins in the 850-950 F range where large amounts of aromatics are formed, its cracking activity was reduced by lowering its surface area by treating with superheated steam before the platinum was dispersed thereon. This permits higher reaction temperatures without undesirable cracking activity. Experiments in isomerization of n-heptane showed that the catalyst must have a surface area not greater than about 65 to 70 sq meters by the Brunauer-Emmett-Teller test technique. Dehydrogenation is induced also by this catalyst; aromatics are produced especially by dehydrogenation of naphthenes such as cyclohexane and homologs. At 900 F and 500 psig, a hydrogen-hydrocarbon ratio of 10:1 and space velocity of 2 vol/vol/hr cyclohexane is converted in about 90 per cent yield or more to benzene; at 950 F the aromatics yield is about 98 per cent. Catalytically reformed naphtha can be leaded to 95 Research octane number or higher with 3 cc. TEL at about 90-92 per cent yield on the raw naphtha charge, these researchers reported.

Platforming vs Thermal Reforming

Two runs on the original Old Dutch Platforming unit show that for the first run the yield was 45 bbl of platformate per pound of catalyst, for the second 42.3 bbl per pound of catalyst, and that catalyst cost was about 9 cents per bbl of feed. Yield was of the order of 95 per cent platformate on the charge volume, with leaded Research octane number of 92-94, say Vladimir Haensel and M. J. Sterba of Universal Oil Products Company. Testing the process by comparative runs on a thermal reforming unit, and a Platformer unit charging Pennsylvania straightrun naphtha, thermal reformate made amounted to 69.3 volume per cent of the charge; polymerized gas added another 6.9 per cent, making a total of 76.2 per cent yield on the charge. Clear octane rating (Research) was 80; with 3 cc. TEL was 90. Platformate yields varied from 91 per cent with a clear octane number of 75 Research, to 70.6 per cent with 94 octane rating. With 3 cc. TEL these values were raised to 89 Research and isooctane plus 0.03 cc. TEL equivalent, respectively.

The Platforming process is applied in several ways to produce stocks of different types. Aromatics, especially benzene, are formed in up to 92 per cent yields on the methylcyclopentane and cyclohexane content of the stock charged, and prospects are that much of the aromatics production of the country will be obtained in future from this and other catalytic reforming processes now operating or being installed. Cracked gasoline can be blended with straightrun stocks to yield products comparable to those obtained from purely straightrun charge; catalytically cracked gasolines may be Platformed to yield aviation base stocks, the authors stated.

Fluid Hydroforming

Investment costs for the new Fluid hydroforming process are considerably below those for thermal reforming-plus-polymerization if investment for loss in thermal reforming gasoline capacity is taken into account, said E. V. Murphree, of Standard Oil Development Company. The outstanding flexibility of the Fluid hydroforming process is one impressive fact, the author stated. As no restrictions are forced on the process by the Fluid technique, restrictions such as maximum carbon-on-catalyst or regeneration temperature, the process can be designed for any octane number product or feed type. Experimental results on a 50-bbl-per-day unit, in a study not yet completed, show octane ratings clear, of 95, with 3 cc. TEL, up to 100 or higher being indicated.

Using a Kellogg molybdenum oxide on alumina gel carrier Hydroforming catalyst, H. G. McGrath and L. R. Hill of M. W. Kellogg Company research laboratory staff report that yields of reformate vary, charging Mid - Continent naphtha, from 98.3 per cent gasoline, at 590 psig and 884 F, with 77.5 Research clear octane number and 33 per cent aromatics, to 82.4 per cent gasoline (10 lb Reid VP), at 932 F, with Research clear octane rating of 91.3 and 100.3 with 3 cc TEL, and 44.5 per cent aromatics. Effect of pressure on aromatics is shown by the yield of 46 per cent at 250 psig and 928 F, although clear octane rating is 81.5 and with 3 cc TEL is 99.6, slightly lower than obtained when operating at 500 psig and 932 F.

In one case cited, the payout time for the new process is one year, the authors calculate. A balance sheet listing costs of operations on a Mid-Continent naphtha show that for 10 lb Reid vapor pressure gasoline the unit cost is $5.04 per bbl, or $34,800 for a 6800 bbl per day unit at 92 per cent conversion, and $1525 per day for gas credit. All debits amount to $30,092 before depreciation giving a net margin of $6233 per day from which to amortize and show a profit on the operation.

Not a single new oil well is needed to increase our national motor fuel output by 14 per cent, says B. R. Carney of Warren Petroleum Company. Consumption of the light recoverable liquid hydrocarbons from petroleum and natural gas as motor fuel is their most economical end-use, representing the greatest power return for the products. As only limited amounts of these ultra-volatile products can be included in regular motor fuels it is necessary to employ special fuel and carburetion systems to handle them suitably. Our natural gasoline and liquefied petroleum gas production can be increased by about 71 per cent of our present output, Carney stated. The clean-burning, high anti-knock properties of propane and butane, especially, make them premium fuels and we can produce 145,000,000 bbl of these natural gas liquids if market consumption demands.

More than 100,000 farm tractors were converted to LPG fuel use in 1950, and the number is expected to be greater in 1951. A large number of buses are being equipped for this fuel, he stated.

Hydrocarbon Synthesis

By proper selection of catalysts and conditions the actions involved in the synthesis of hydrocarbons from carbon monoxide and hydrogen mixtures may be controlled within wide limits, P. C. Keith and J. H. Arnold of Hydrocarbon Research, Inc., reported. At atmospheric pressure and 470-650 F with nickel and cobalt catalysts, methane is the main product. Iron or other metal on kieselguhr yield practically all paraffins. Boost the conditions to 575-675 F and 225-699 psig and an iron catalyst mainly olefins in the gasoline range are produced (The Hydrocol Synthesis). Fischer and Pichler at 1500-15,000 psig and 300-480 F with a ruthenium catalyst made very high molecular weight paraffin waxes, and so on.

The Hydrocol catalyst is mainly iron oxide, with an alkali promoter such as potassium hydroxide; the catalyst is conditioned by reducing it to the metal, iron, and then is exposed to conditions that promote carbide formation rather than oxide in operation, which includes exposure to carbon monoxide. Catalyst performance is dependent largely on its "environment," that is, temperature and pressure, charge concentration and space velocity; the sum of these conditions must be held to that value that will retard reversion of the iron to its oxide. The purpose of the alkali is to increase selectivity; the more alkali, within limits, the heavier the average molecular weight of the product. High selectivity is controlled largely also by control of the concentration of hydrogen and carbon monoxide, and the concentration of carbon dioxide in relation to the other two main constituents.

Cost data on the production of petroleum-like hydrocarbon materials from oil shale and from coal indicate that synthetic motor fuel from oil shale may be competitive with that from petroleum, says H. H. Storch of the U. S. Bureau of Mines. Costs for coal-derived motor fuel will be "several cents per gallon more than motor gasoline" from petroleum, not crediting this last operation with any return from chemicals produced. Credit the chemicals at current prices and "the over-all operation would be profitable," Storch claims. One main objection to most of the published approximate estimates of cost is that they fail to consider the sharp differences in the amounts of engineering and large pilot plant data upon which the different estimates are based, and present estimates can be appraised critically only in the light of the type and amount of data available for each process, the author concludes. * * *

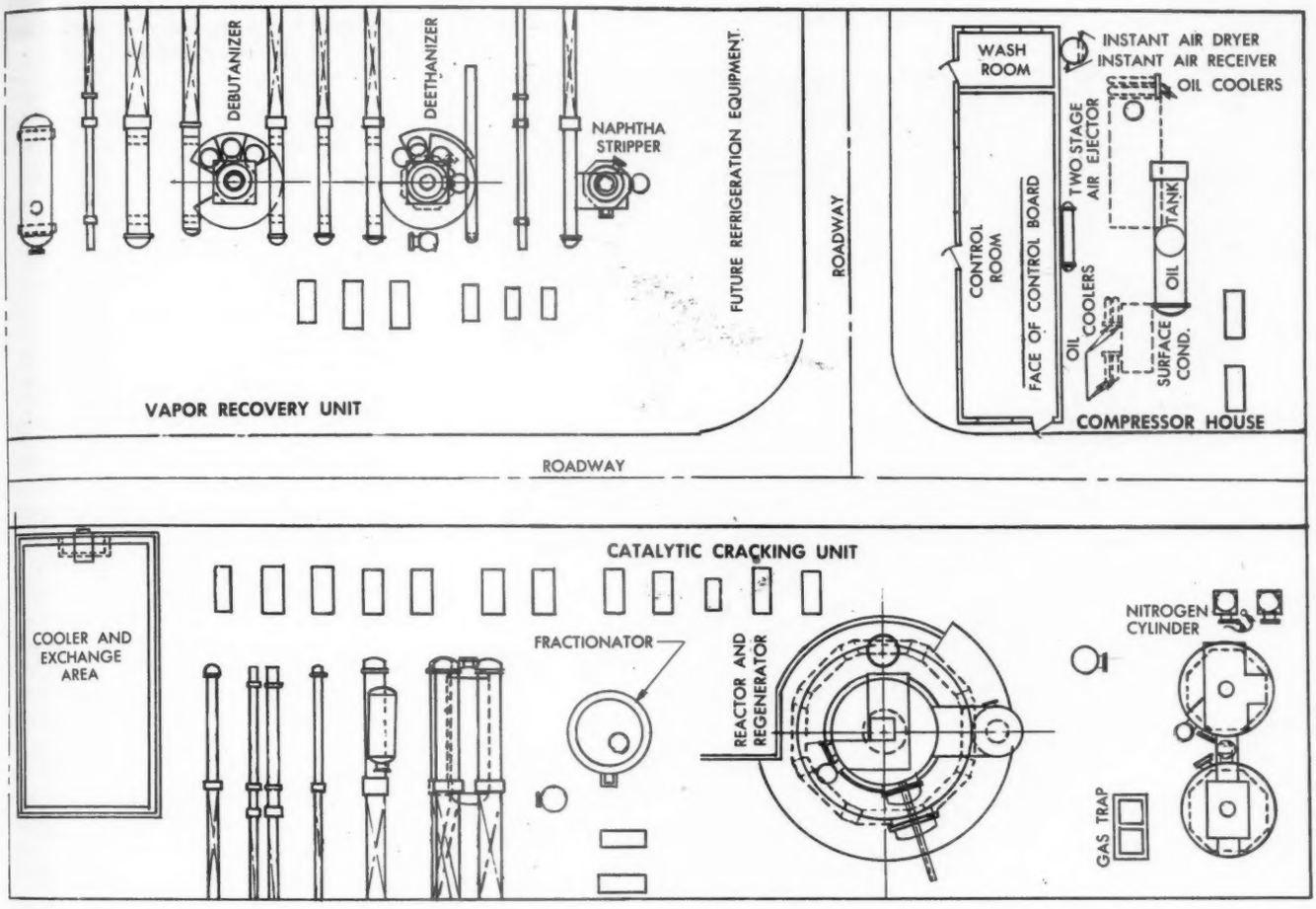


FIG. 1. Plot plan of No. 2 Fluid catalytic cracking and vapor recovery unit of Pan-Am Southern Corporation.

New Design Features in Cat Cracker

Simplified design reduces installation and operating costs open layout facilitates inspection and maintenance.

H. K. WHEELER*

PAN-AM Southern Corporation recently put in operation the second Fluid catalytic cracking unit at its El Dorado, Arkansas refinery. The first unit, which was constructed in 1943, as part of a defense plant, is currently capable of processing 8000 bbl per day of raw oil charge with a coke burning capacity of 4400 lbs per hour. With the operation of the second unit engineered and constructed by Foster Wheeler Corporation, the El Dorado refinery, which processes 30,000 bbl per stream day of mixed Arkansas-Louisiana crude, will have almost complete flexibility with regard to furnace oil production. The second Fluid catalytic cracking unit is designed to process 7000 bbl per day of fresh feed, 2300 bbl per day of recycle, and has a coke burning capacity of 7000 lbs per hour. It is a heat-balanced unit containing neither recycle catalyst coolers nor preheat furnace. The main catalyst vessels are of unitary design with the reactor above the regenerator, and the engineering design contains several new features that enabled savings on the initial investment, and also many items designed to reduce operating and maintenance costs.

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EXCLUSIVE

The plot plan of the unit, which is shown in Fig. 1, was laid out to facilitate maintenance. The pumps have sufficient free area around them for easy maintenance. In addition, a road branches off east and west on the plot plan to facilitate the movement and handling of heavy equipment. With this open plot plan, and outside pump rooms, piping runs are immediately above the pumps and about 12 ft above grade, and as a result pipe maintenance is simplified. In addition, this feature enables the majority of the instruments to be at ground level and thus expedites instrument maintenance.

There is no elevator on El Dorado's

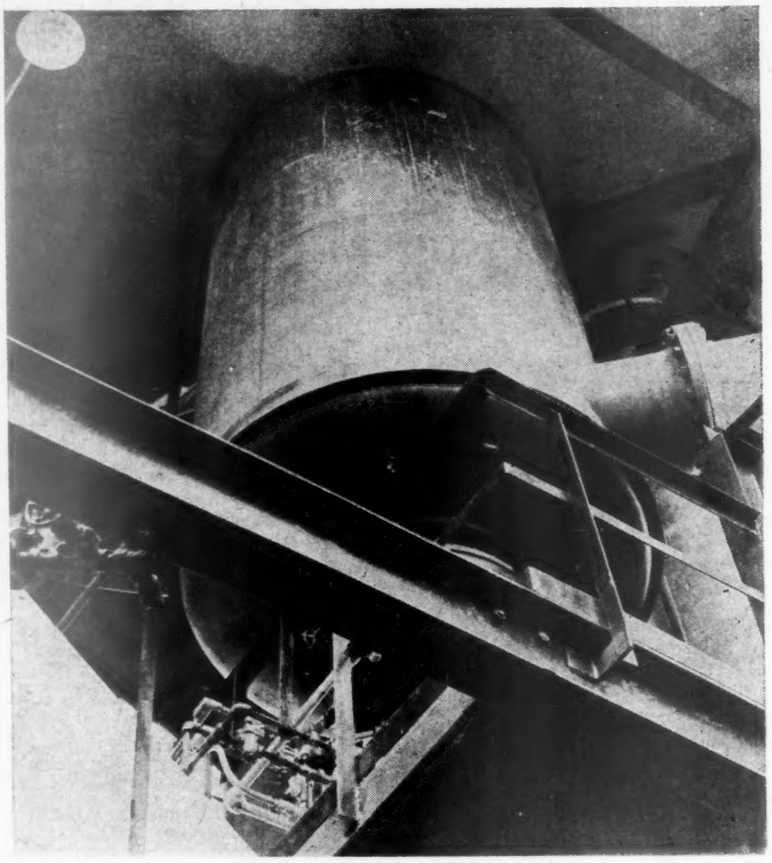


FIG. 2. View of regenerator bottom showing air heater welded directly to bottom head.

TABLE 1. Comparison of actual and design conditions.

	Actual	Design
Raw oil charge, BSD	7530	7000
Gas oil recycle, BSD	1825	1700
Slurry oil recycle, BSD	630	600
Total charge, BSD	9985	9300
Yields, basis raw oil charge		
Dry gas, wt. per cent (C_3)	11.0	10.0
Propane-Butane, vol. per cent	8.4	10.7
Gasoline, vol. per cent	39.1	34.8
Coke, wt. per cent	8.5	7.3
Conversion, vol. per cent	56.8	55.0
Process conditions		
Reactor pressure, psi	10.	10.
Reactor temperature, °F	895	910
Regenerator pressure, psi	16	15
Regenerator temperature, °F	1120	1100
Catalyst circulation, T/M	10.5	12.9
Catalyst loss, T/D	2–3	1–2

second Fluid catalytic cracking unit. The unit was engineered to hold the highest operating level to a minimum elevation; the top normal operating level is at an elevation of 11 ft. Unit process control is also arranged so that it is not necessary to operate very often from the top operating level situated at 90 ft above grade. The absence of an elevator for maintenance is compensated for by the installation of numerous facilities for hoisting equipment and materials during shutdowns.

For startup preparations an air heater is required for a Fluid catalytic cracking unit to get the catalyst beds to operating temperature prior to processing oil. On Pan-Am Southern's new unit this air heater is welded directly to the regenerator bottom head (Fig. 2). This arrangement eliminates large hot lines between the regenerator and the air pre-heater. The attendant problems of line expansion and large bypass valves were also eliminated by this expedient.

Both the air for catalyst regeneration and the gas for processing in the vapor recovery unit are compressed in centifugal turbo compressors. These units are housed in an open compressor room covered by a roof and shielded on one side by the control room (Fig. 3). The surface condenser for the compressor turbines is located on the roof of this compressor house. The centrifugal gas compressor occupies an area no larger than a large centrifugal pump and as a result considerable housing is saved over that required for the protection of reciprocating machines. The centrifugal gas compressor is the third such unit installed for this service in a petroleum refinery.

All the pumps in this unit are placed outside, adjacent to the equipment they serve. This feature not only facilitates maintenance on the pumps, but it considerably reduces the piping on the unit. In addition, by locating tower bottom pumps adjacent to the tower, short suction lines are possible, resulting in the setting of towers and drums on concrete piers only 6 to 8 ft above grade.

Description of Process

Pan-American Southern Corporation's second Fluid unit at El Dorado, Arkansas, is designed to process 7000 bbl per day of a combined coker gas oil-catalytic cycle gas oil, of about 27.2 deg (Fig. 4). The expected coke yield at 55 per cent conversion is 7.3 per cent on this feed. In addition, 2300 bbls per day of recycle to the reactor are contemplated, made up of 1700 bbl per day of 18 deg API heavy

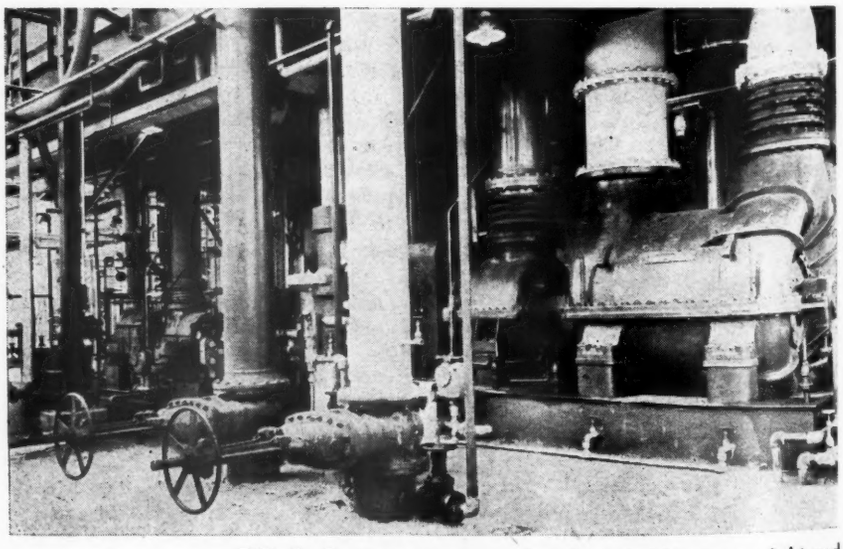


FIG. 3. Compressor room showing air blower on right and gas compressor on left. Note size of gas compressor.

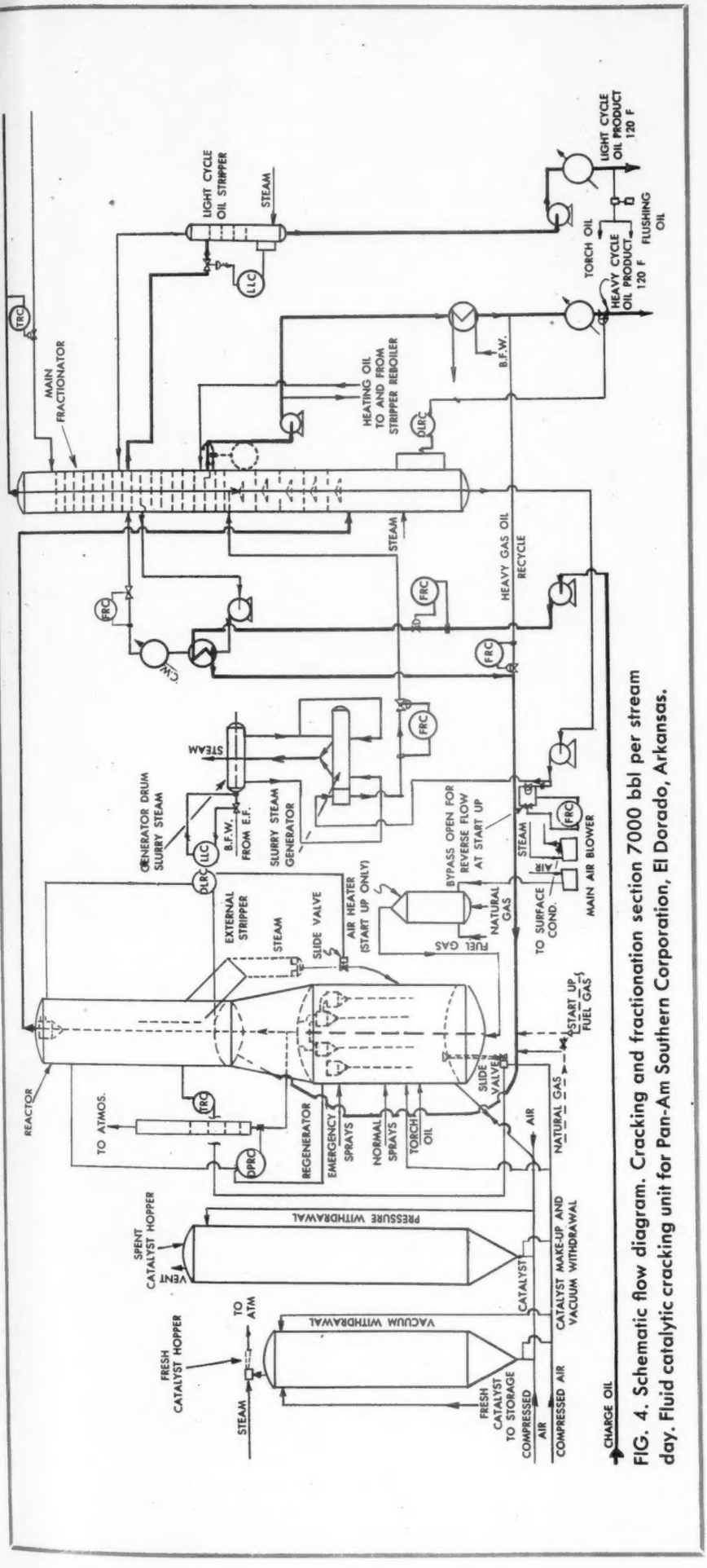


FIG. 4. Schematic flow diagram. Cracking and fractionation section 7000 bbl per stream day. Fluid catalytic cracking unit for Pan-Am Southern Corporation, El Dorado, Arkansas.

cycle oil and 600 bbl per day of 8 deg API slurry oil from the bottom of the fractionator. The new unit has operated under conditions approaching this design, and a comparison of the design yields with the actual yields is presented in Table 1. Catalyst fines carried over to the fractionator are continuously returned to the reactor with the slurry recycle. The raw oil charge, along with the recycle streams, is charged to the reactor riser, through a series of small nozzles. It is then carried through this riser to the reactor and catalytically cracked to form gasoline and other lighter products. The coke produced during this cracking lays down on the catalyst.

The spent catalyst leaves the reactor through an internal well into a standpipe and then into the outside baffled stripper. In this stripper hydrocarbons entrained with the catalyst are removed with steam. The spent catalyst then flows through a single slide valve into the top of the dense bed of the regenerator. As the catalyst enters the regenerator bed some of the remaining oil is stripped from it by the action of the flue gases, and then the remaining carbon is burned from the catalyst with air supplied by the centrifugal air compressor. A baffle shields the spent catalyst inlet to the regenerator to prevent short circuiting of partially regenerated catalyst directly to the regenerated catalyst standpipe. The flue gas resulting from the combustion of the coke on the catalyst passes through three sets of two-stage Ducon cyclones for catalyst recovery and then out through the regenerator stack. Spray water is normally admitted to the dilute phase of the regenerator to cool the flue gas. In addition, emergency sprays are actuated by high temperature controls in the regenerator dilute phase. The regenerated catalyst flows down a standpipe through a single slide valve where it meets the oil charged to the reactor riser.

This Fluid catalytic cracking unit is a heat balance unit, all the heat necessary for the completion of the reaction being supplied by the combustion of the carbon produced. There is a torch oil connection into the regenerator so that oil may be burned to provide the heat necessary to hold the unit in heat balance if coke production is insufficient for this purpose. The pressure on the regenerator is regulated by a single port-double slide, Chapman slide valve. One of the slides is manually operated while the other is actuated by the pressure control instrument. In addition, the regenerator stack contains four orifice plates. These plates reduce the pressure drop necessary across the slide valve and thus reduce velocity and erosion.

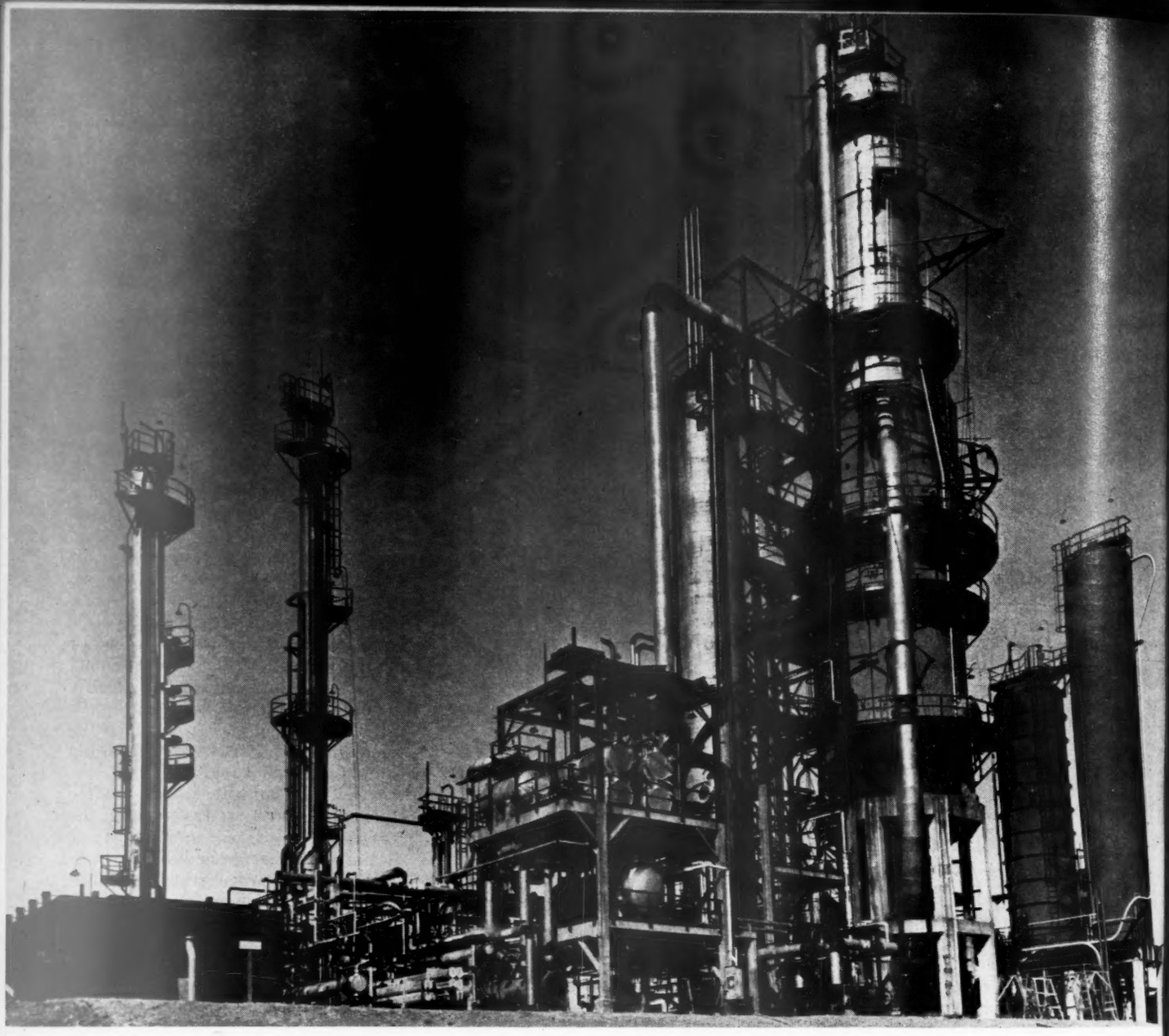


FIG. 5. General view of Pan-Am's second fluid unit, showing left to right, catalyst storage drums, reactor regenerator, main fractionator, deethanizer, and debutanizer.

Catalyst flow from the regenerator to the reactor is controlled by the reactor temperature, catalyst flow from the reactor to the regenerator is controlled by the reactor bed level. This is more or less a conventional system of control for such a unit. The regenerator stack slide valve is actuated by a differential pressure controller, controlling the difference in pressure between the reactor and the regenerator. In this manner slide valve differentials are relatively constant. The catalyst/oil ratio for the heat balance is 12½ to 1, based on total feed to the unit, with fresh feed entering at 170 F and the reactor operating at 910 F, and the regenerator at 1100 F.

The cracked oil vapors leaving the reactor pass through three sets of single stage Ducon cyclones into the bottom of the main fractionator. Here the oil vapors are desuperheated by the circulation of 20,000 bbl per day of slurry oil reflux which, in addition, scrubs the catalyst from the reactor effluent. The slurry oil reflux is cooled in a horizontal steam generator producing 22,000 lbs per hour of 275 lb steam. A heavy gas oil for recycling to the reactor is trapped off on the third tray in the fractionating section. In addition a portion of this steam is withdrawn to supply heat to the naphtha stripper reboiler in the vapor recovery unit and is returned to the main fractionator as reflux. Intermediate reflux on the tower is withdrawn from the ninth tray and passes through a single feed preheat exchanger and a water cooler back into the tower at the tenth tray. A light gas oil produced, normally used as thermal unit cracking charge, is withdrawn from the eleventh tray of the fractionator into a light cycle oil stripper where 40 lb steam is employed to remove the gasoline components from this trapout. The bottoms from this stripper are pumped through a water cooler to storage. This product is also used as torch oil to the regenerator, and flushing oil to the slurry reflux pumps. The overhead from the main fractionator is condensed in 4 shell-and-tube exchangers and accumulates in the overhead receiver. Gas from this drum passes through a compressor knockout drum into the suction of the turbo compressor where it is compressed for delivery to the gas plant. The liquid hydrocarbon from this receiver is used as top reflux for the fractionator. The net gasoline from the operation is transferred to the vapor recovery unit for further processing.

In the vapor recovery unit a propane-butane stream is separated for polymerization and alkylation charge,

and the gasoline product is debutanized prior to further treating (Fig. 6). The vapor recovery unit consists of three towers: A naphtha stripper, a deethanizer, and a gasoline debutanizer. The naphtha production from the main fractionator is introduced into the top of the naphtha stripper where it is reduced to a stream containing essentially heptane and heavier hydrocarbons. The bottom from the naphtha stripper is exchanged with the naphtha stripper charge, cooled, and then introduced into the top of the deethanizer as sponge oil to increase the recovery of the propane-butane and reduce light lean oil losses. The vapors from the naphtha stripper are introduced into the bottom of the deethanizer, where they assist the vapors from the deethanizer reboiler in stripping undesirable light ends from the deethanizer bottoms. The catalytic gas that is compressed to 85 psi by the turbo gas compressor is introduced about half-way up in the deethanizer. A light lean oil of debutanizer bottoms is introduced on the tenth tray from the top for the preliminary absorption. The sponge oil mentioned above recovers C_4 and C_5 stripped from this lean oil and increases the absorption of the propane-butane from the catalytic gas. In addition to the vapors from the naphtha stripper used for stripping unwanted components from the deethanizer bottoms, the bottom of the deethanizer is reboiled to assist in the separation. The vapor recovery section is designed for 55 per cent recovery of the propane-propylene, and the corresponding recovery of the butane-butylene stream. The deethanizer overhead, which contains small quantities of butane-propane corresponding to these recoveries, is introduced directly into the refinery fuel gas system which operates at about 30 psi. The deethanizer bottom is pumped to the debutanizer where the absorbed components are fractionated to produce a C_3-C_4 overhead, and a C_5-400 debutanized catalytic naphtha. The debutanizer overhead is charged to a depropanizer at an existing gas concentration unit, where the propane-propylene is taken overhead and charged to polymerization, and the bottom stream charged to an alkylation plant. The debutanizer gasoline is run down to a storage tank from which it is transferred to a doctor treating unit. The sweet gasoline is then blended into the pool gasoline.

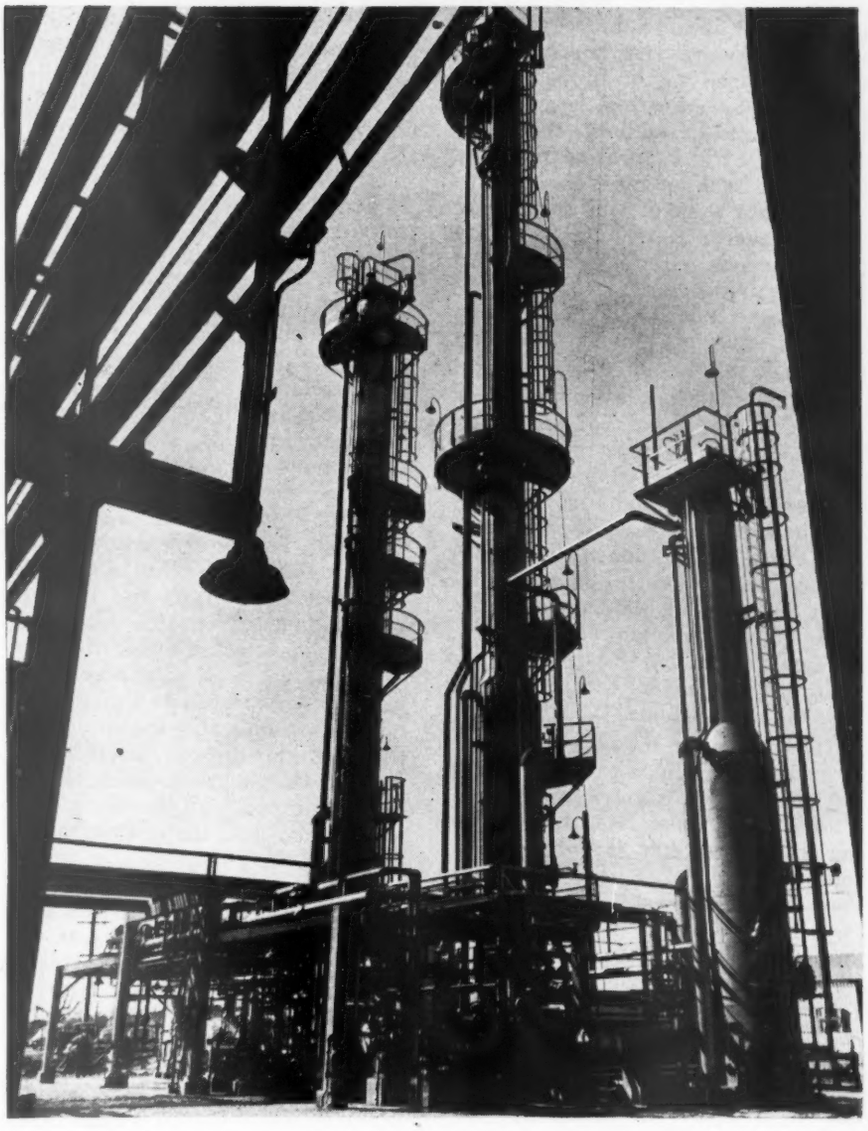


FIG. 6. Vapor recovery unit showing outside pump room. Towers are naphtha stripper, deethanizer, and debutanizer. Note simplicity of pipe runs.

Mechanical Details

Catalyst for the unit is currently synthetic of both the ground and MS types. Catalyst cars are unloaded on a spur about 60 ft from the battery limits, the catalyst being unloaded into a fresh catalyst hopper 13 ft in diameter by 45 ft tall. This hopper is designed to hold 100 tons of fresh catalyst. The catalyst unloading system from the cars to this hopper is extremely simple. A steam jet pulls a vacuum on the hopper and the unloading system operates much as a vacuum cleaner. The catalyst unloading line enters the hopper about 9 in. from the top tangent line and the change in velocity settles the cataylst into the drum. There are no filters or cyclones on the catalyst unloading system. Preliminary indications are that very little catalyst is lost during the unloading. To enable this system to operate in this manner, the fresh catalyst hopper was designed for vacuum. The vacuum cleanout connections on the catalyst system are also connected into this drum, thus simplifying the design and installation of that system. Catalyst from the fresh catalyst hopper can be transferred to the unit in either a 6- or 4-in. catalyst filling line. In addition, catalyst can be transferred from the fresh catalyst hopper into the spent catalyst hopper. The spent catalyst hopper is 13 ft in diameter by 65 ft high, and is designed to hold 220 tons of spent catalyst. Air for the catalyst addition is supplied either from the 100 lb plant air system or from the turbo blower.

The turbo air blower is an Ingersoll-Rand 4-stage centrifugal air compressor designed to handle 22,000 cu ft per minute of air at suction conditions. The design discharge pressure on this machine is 34.5 psi absolute. The centrifugal air blower is powered by direct drive from a General Electric DR multi-stage condensing steam turbine of 2130 bhp. The design speed of this machine is 5000 rpm. The discharge from the air blower goes directly to the air heater welded to the bottom of the regenerator. As this is

the only air inlet to the regenerator, no control valves are required. The quantity of air to the regenerator is controlled by adjusting the speed of the machine. In addition the check valve on the air compressor discharge is actuated by oil pressure on the blower governor system, and as a result the check valve offers no restriction to the flow of air. To minimize the total head required of the machine a Venturi flow meter is installed on the suction for metering the air to the regenerator.

The air preheater, which is welded directly to the bottom of the regenerator, is 6 ft in diameter and about 14 ft long. The vessel is lined with Quigley insulating and firebrick panels. The air heater is equipped with a John Zink burner, and a John Zink electronic safety control that automatically shuts off the flow of gas to the burner in case the flame of either the pilot or main burner goes out. The air preheater is designed to liberate 25,000,000 btu per hour.

The reactor and the regenerator are of unitary design with the reactor placed above the regenerator. The reactor is approximately 15 ft in diameter and 40 ft high, is unlined, and constructed of A-285 grade C carbon steel. Oil and catalyst flow to the reactor is introduced into the bottom head through a catalyst riser which is covered by a hemispherical distributor. This distributor head is lined with A. P. Green KAST SET KS-4 refractory, and is made of ¾-in. steel plate. The reactor grid is hemispherically shaped to allow for expansion and simplification of installation, and is perforated with 2-in. holes. There is an internal segmental well with a 4-ft radius, which acts as a standpipe for catalyst to the stripper and prevents the stripper effluent from entering the catalyst bed. The holes in this well enable any bed level to be carried in the reactor without interrupting catalyst flow to the stripper. Catalyst normally flows through the holes into the stripper and the steam and hydrocarbon vapor from the stripper flow upward from the well into the cyclones. The spent catalyst stripper is 6 ft ID by 16½ ft long and contains five disc-and-donut baffles for dilute phase stripping. Steam connections in the bottom of the stripper introduce the steam for stripping. A grid in the bottom of the stripper assists in the distribution of this stripping steam. The regenerator grid also is hemispherical in shape. The regenerator is lined with three inches of A. P. Green SAIR-KAST SK-7 monolithic insulating cement, followed by one inch of A. P. Green KAST SET KS-4 refractory cement, the latter held in place by ¾ in. hex steel mesh. The spent catalyst inlet to the regenerator is shielded by a baffle about 3 ft square, constructed of ½-in. plate and lined with 1 in. of KAST SET KS-4. In many places, in both the reactor and regenerator, KAST SET KS-4 is used to protect metal that would normally be exposed to extreme corrosion and erosion. Air to the regenerator is distributed under the grid by a distributing device similar to that employed on the reactor riser. The regenerator catalyst standpipe, which is 24 in. in diameter, is covered by a screen to prevent any loose refractory from entering the standpipe and finally lodging on the slide valve.

The main fractionator, which separates the gasoline produced from the gas oils, is 9 ft 6 in. in diameter and 81 ft tall. The tower is equipped with 5 disc-and-donut baffles in the lower desuperheater section, and 18 single-pass bubble cap trays. There is a steam spider in the bottom of the tower and an umbrella hood over the suction to the slurry reflux pumps. The bottom section of the tower, up to the third bubble cap tray, is clad with a 11-13 per cent chrome liner. The tower is equipped with 4 manways permitting access to the drawoff and reflux trays.

The gas compressor on the El Dorado Fluid cracking unit is a Clark 6-stage centrifugal compressor driven by a Worthington-Moore 1000 hp multi-stage condensing steam turbine. The gas compressor is designed to handle 4000 cu ft per minute at intake conditions and to compress this material to 90 psi. The design speed of the compressor is 8500 rpm. Sweet natural gas is admitted to the shaft seals on the compressor to prevent corrosion products from building up on the seals and damaging them at the high operating speeds. This is the third such compressor installed in this type service and operations to date on this unit have been satisfactory. A compressor of this type does not have the range of capacity of a reciprocating engine; however, with proper installation and instrumentation, operation in this type service meets requirements. Because of the head-capacity relationship and the theory behind a centrifugal gas compressor, it is impossible to start up such a machine against design pressure. Without gas flow, the compressor will put up only about 50 per cent of its design head. To circumvent this objection, a bypass to the suction or flare is required so that flow can be established prior to the instant the machine is called on for pressure. This type installation, or recycle, makes it possible to operate the compressor at low charge rates and still have design pressure on the discharge.

The naphtha stripper, deethanizer, and debutanizer are carbon steel towers somewhat standardized for gas recovery plant service. Both the catalytic section and the vapor recovery system contain blowdown and open drain facilities. The blowdown line on the light hydrocarbons (gasoline and lighter), both hot and cold, connects directly into a 8 by 30 blowdown drum outside the battery limits. The vapors from this drum are carried off through an 8-in. line to a ground level flare. Light hydrocarbons cooled by natural refrigeration in the blowdown drum are pumped by a blowdown pump into the unit slop system.

Hot gas oils from the catalytic section can only be blown down through the box cooler provided for this emergency. A pumpout pump is tied into this system for pumping out the last trace of hot fluid from the system. In some cases the water and oil drains from drums and vessels are tied directly into the blowdown system and go to the blowdown drum. Open drains carry away pump gland leakage, sample points, and other streams containing varying quantities of both oil and water. This open drain system, which ties into the normal storm water system, is thoroughly trapped and the drainage passes eventually to an oil separator box. The sanitary sewer for the unit is separate from this system and includes a septic tank.

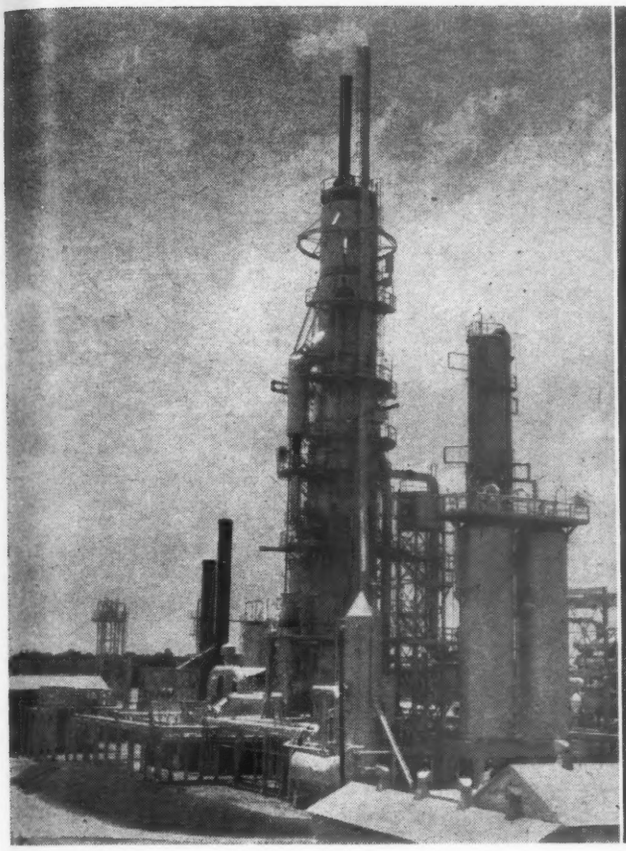
The terrain of the plant location and its corresponding tankage is such that it is impossible to take suction off the feed tanks with the unit charge pump. As a result, an 8 by 30 surge drum, which holds about one hour supply of feed, is located adjacent to the unit and the charge pump takes suction off this drum. The drum is fed by an auxiliary feed pump from two 55,000 bbl tanks that serve as feed tanks for this unit.

Gas oil production is run down into three 10,000 bbl tanks and then transferred to the thermal cracking system of the refinery.

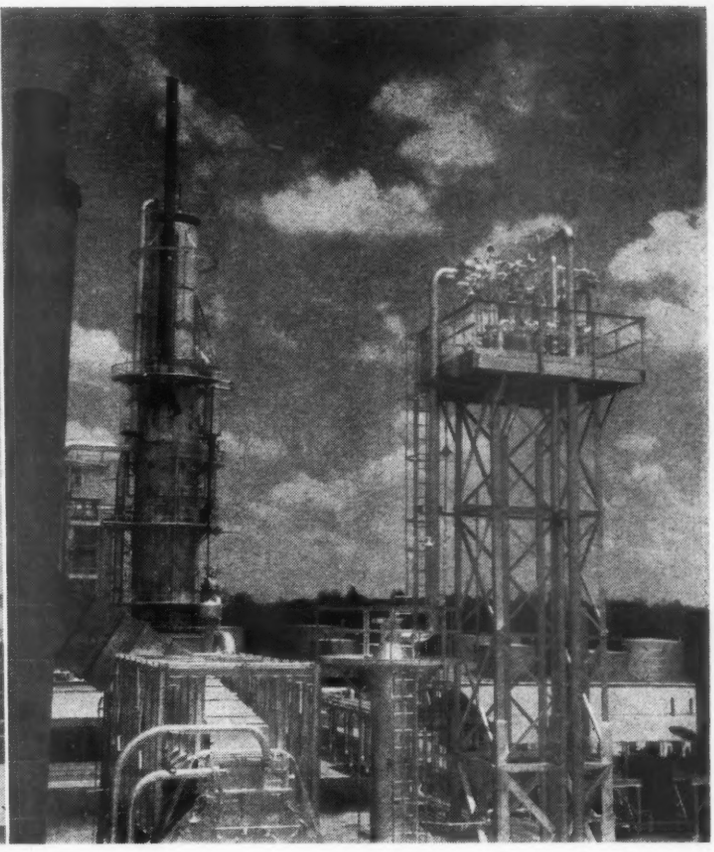
One 10,000 bbl tank serves as gasoline feed surge capacity between the cat cracking unit and the doctor treater. ***

Petrochemicals Flourish

The petroleum chemical business in the United States has achieved a notable growth while supplying hundreds of new products to American industry and consumers. In 1925, less than six million pounds of organic chemicals were obtained from petroleum. By 1950, the total approximated 14.5 billion pounds.



Reactor-regenerator, the cat storage hoppers, and blow down sump at the cat unit.



Barometric condensers at the vacuum unit of McMurrey Refining Company, Tyler, Texas.

Flexibility Achieved by Modernization

Topping-thermal cracking refinery revamped and expanded to meet current demand for products

ARCH L. FOSTER*

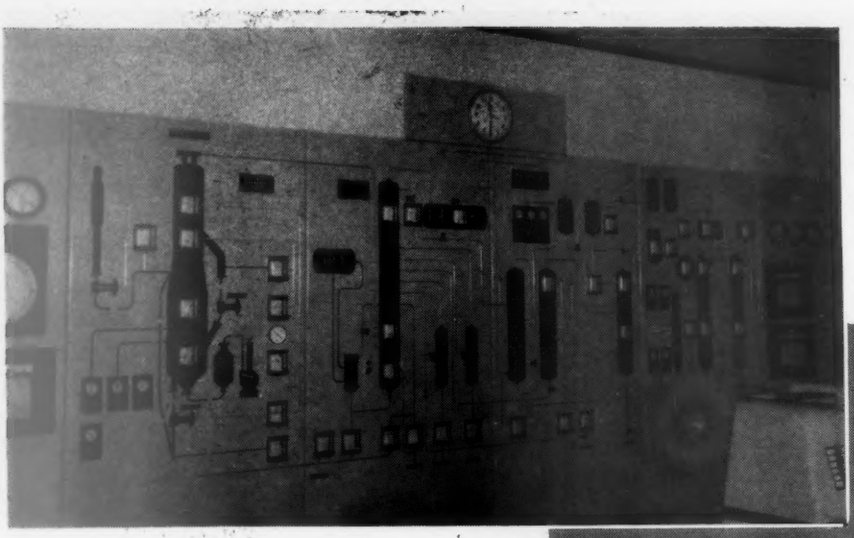
BEGINNING the postwar expansion period with a prewar refinery that had facilities only for crude topping, heavy oil cracking by thermal means (gas polymerization), and conventional treating-sweetening units, McMurrey Refining Company at Tyler, Texas was convinced of the necessity for revamping and modernizing its entire facilities to meet postwar competition in quality and quantity of products. The inevitable trend toward higher and higher octane ratings to meet the peacetime requirements in motor fuels combined with the rapidly growing demands for distillate furnace (heating) oils for diesel fuels of higher and higher quality specifications and the realization that higher volatility in gasolines was to be part of the postwar quality needs, the decision was made to rebuild the existing plant completely and to add those units required to give the products qualities and the processing flexibility needed to meet competition. Universal Oil Products Company, Chicago, Illinois was called in to prescribe and to supervise the entire job.

The old plant included principally a crude unit with fractionator for separating straightrun gasoline, naphtha, kerosine, etc. A Dubbs 2-coil thermal cracking unit was in operation, with its reaction chamber, flash chamber, and fractionator for making conventional cracked distillate as was typical of pre-World War II refining operations. A non-selective catalytic polymerization unit recovered octane numbers and additional motor fuel gallonage from the plant's cracked gases, and a conventional "Doctor" treating unit sweetened the motor fuel as had been American practice for nearly a generation.

To this list has been added a fluid catalytic cracking unit of a nominal capacity of 4000 bbl of charge per day; a vacuum-visbreaker unit including a

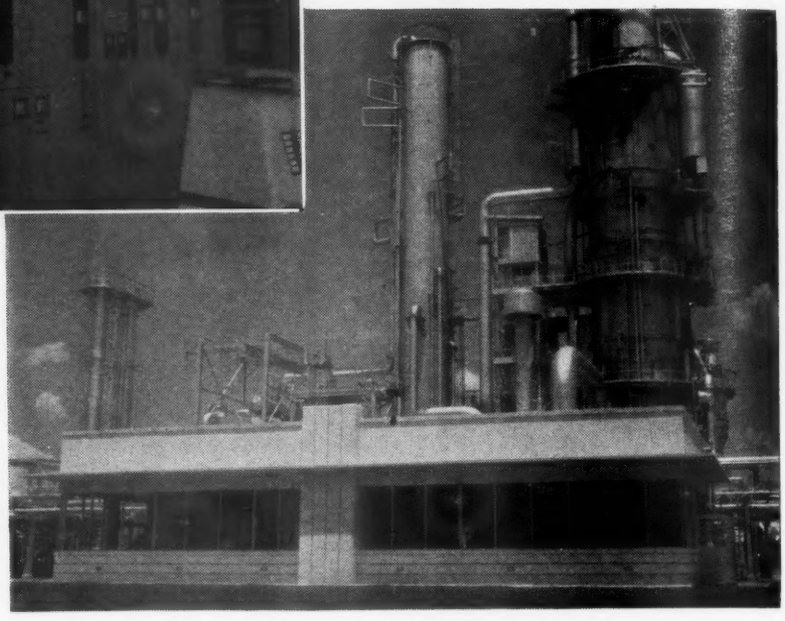
EXCLUSIVE

*Editor, Refining and Gas Processing.



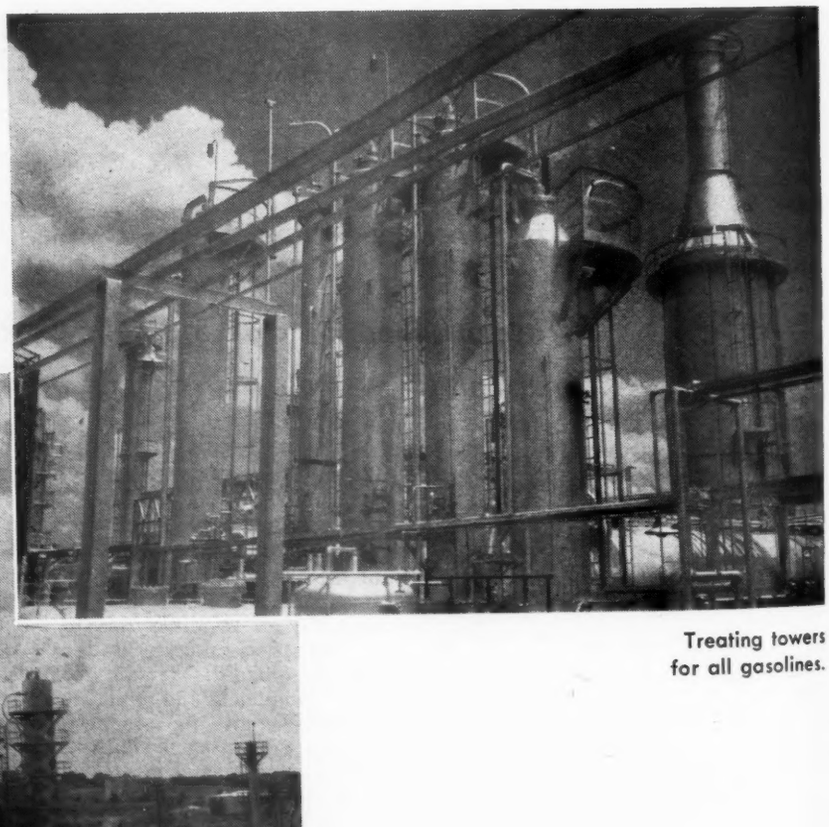
At left is catalytic control board.

Below is exterior of cat control room and blower room.



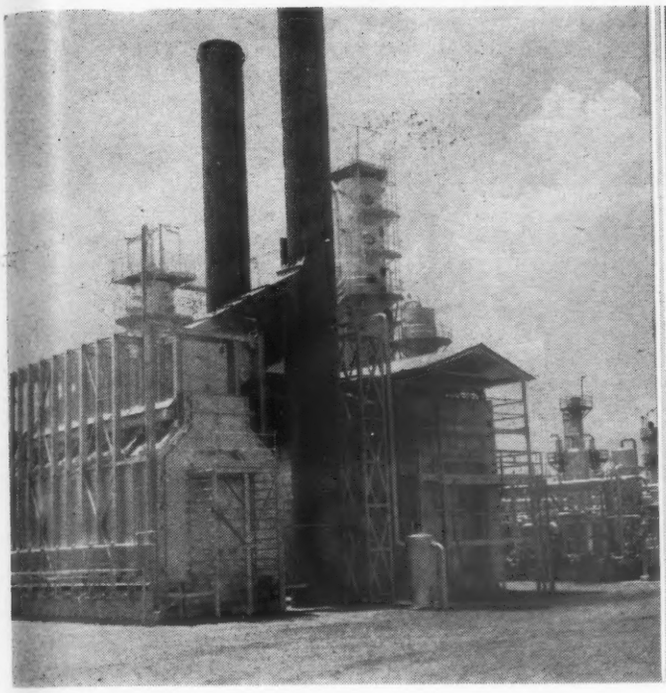
heater coil in the old Dubbs furnace, and the old Dubbs reaction chamber to which has been added several trays, a center well accumulator, and a few nozzles, along with a Shutte-Koerting barometric condenser that pulls vacuum of about 28 in. on this vacuum column top. Correspondingly, the side-by-side pans in the old Dubbs fractionator were removed, as were three trays below the center well. Some nozzles were added to make of this tower a flash fractionator, and a new polymerization unit has been added. Construction work was largely in the hands of Refinery Engineering Company of Tulsa for the entire modernization program.

A new B and B design water treating unit has been installed also, which includes a sodium zeolite section and a demineralization section. All water used in the plant passes through this treater, making contact with the zeolite first, which removes all cations except sodium; thence to a second chamber where hydrogen is 'traded' for sodium

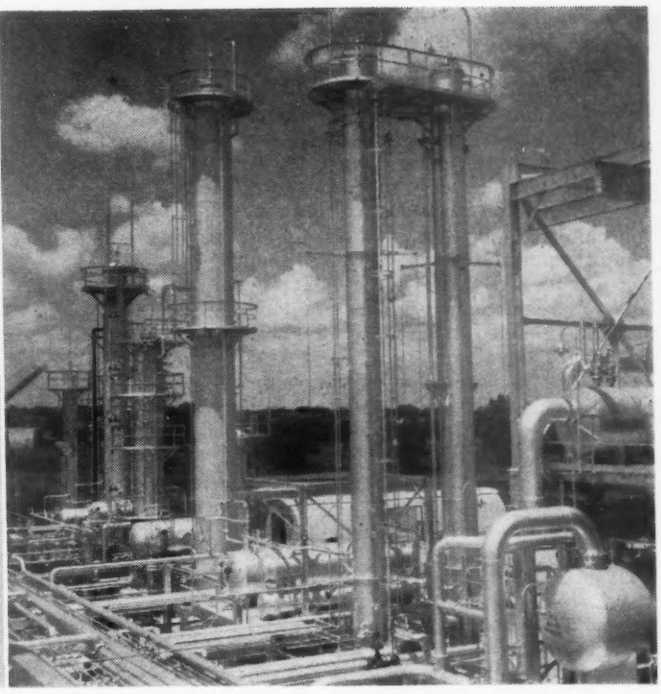


Treating towers for all gasolines.

General view showing towers for crude, vis-breaking, thermal, and fractionating.



The vis-breaker furnace and the thermal cracking furnace.



Poly unit, cat debutanizer, gas converter, and secondary absorbers at cat unit.

and the water becomes slightly on the acidic side. The next treating step is in the degasifier to eliminate gases, followed by further treatment in a third chamber where hydroxyl ions are substituted for anions, completing the demineralization of the process and all other waters used.

A Tretolyte-designed desalter unit is installed also for desalting the incoming crude, and a Petrochem heater is primary crude heater unit. The original plant had two B and W boilers, each of 16,000 lb per hour at 210 lb pressure. A third boiler of 26,000 lb per hour capacity also at 210 lb pressure has been installed to meet the added steam requirements. Included also is a deaerating feed water heater.

Three air compressors provide air for plant uses, at 110 psig. Two are those employed in the original plant, while a third one, size 12 by 13 in. has been added to meet the increased load. The catalytic unit employs a 5-stage Elliott blower driven by a 6-stage Elliott steam turbine, using Republic Instrument Company controls. An Electric Machinery Manufacturing Company emergency electric generator of 12½ Kva. capacity is provided, and is equipped with an automatic solenoid 'kick-on,' which acts if and when other electric current sources fail.

The controls and indicator - recorder installations for the topping unit, thermal cracking unit, and visbreaker are grouped in one room, and include 20 Brown recorders and two main recording potentiometers and a 48-point Brown temperature indicator on the operator's desk. A Panellit Board is the control center for the cat unit, poly unit, and gas concentration unit.

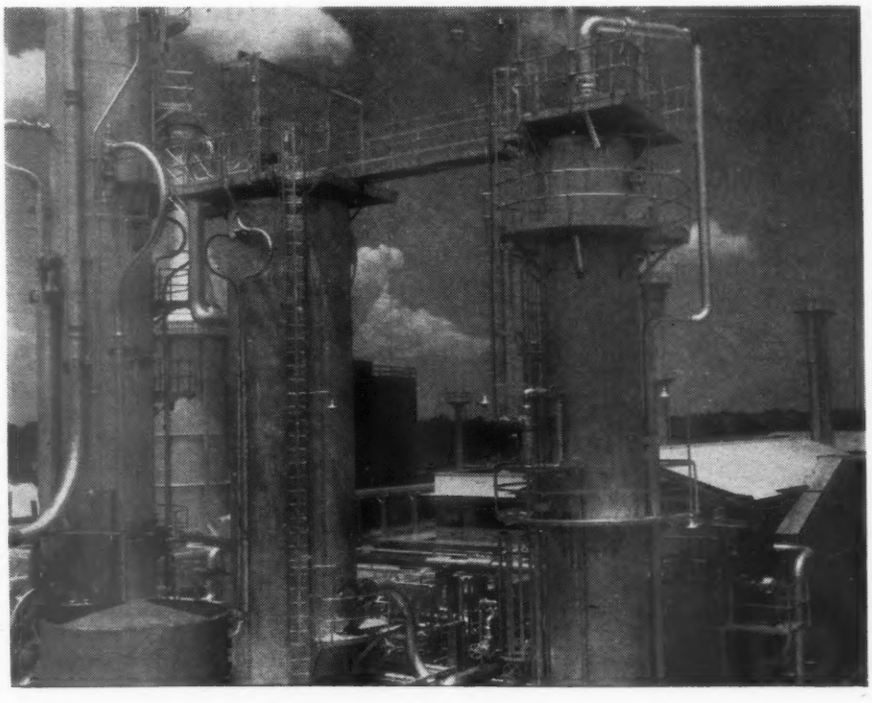
Practically all line and tower insulation is covered by aluminum sheeting, either smooth or corrugated. Aluminum instrument air lines are installed throughout the new part of the refinery.

Before beginning the process of modernizing the refinery, the consulting engineers opened and inspected every vessel in the then existing refinery. After deciding on the details of the plan to be carried out, each item was looked over and repaired or replaced as the need was found. Tower trays were removed, inspected and put into first-class condition or replaced. Heat exchangers were inspected and revamped, as were heater coils and all other equipment retained for the new plant.

Operating Routine

East Texas crude containing some 40 lb of salt per 1000 bbl is treated in the desalting unit, exchanges heat with thermal cycle oil in Tubeflo and GR-G-Fin units, and is then heated in the Petro-

Clouds float above thermal cracker fractionator, vis-breaker flash chamber, and vacuum column.



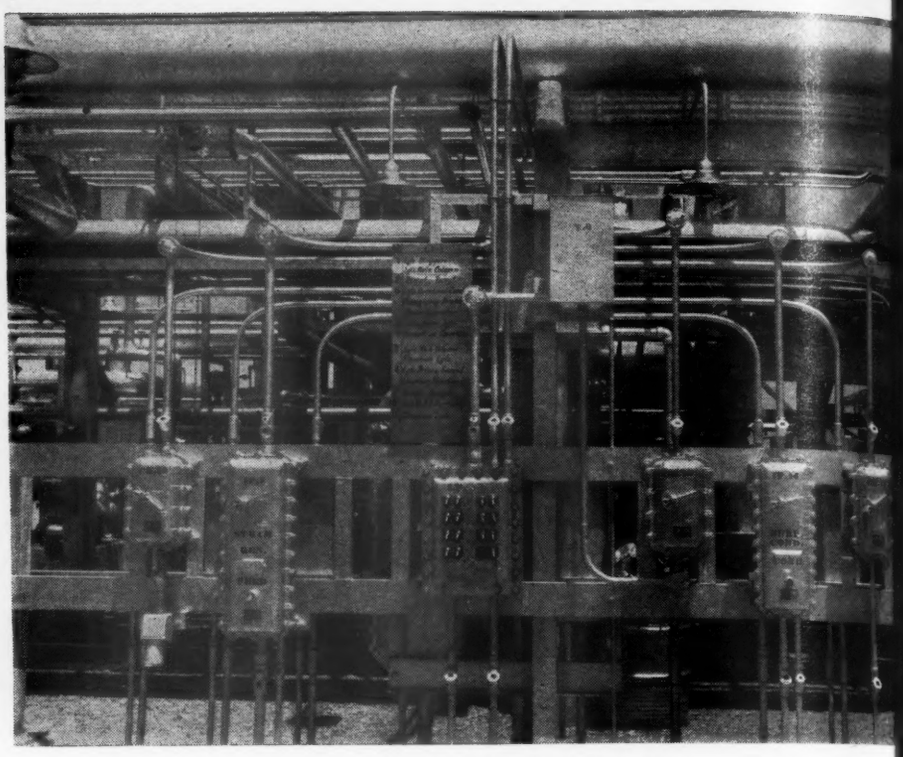
chem heater and flashed in the crude fractionator. Overhead from this fractionator is straightrun gasoline, condensed in the water cooling tower in Bentube sections, and is stabilized finally in the old stabilizer column. From this side of this tower are drawn streams of naphtha and of kerosine, with a diesel fuel stream withdrawn lower down the column when desired. Bottoms from this column are charged to old Dubbs heater and to the vacuum column and are flashed to provide lighter and heavier streams and very heavy bottoms that are blended to No. 6 fuel oil. Charge for the Fluid catalytic cracking unit is the main product stream from this vacuum (visbreaker) tower, with overhead vapors from which are produced furnace oil and other desired streams.

Charge to the Fluid unit is processed in the conventional manner for the production of high octane number motor fuel component, along with cracked gases processed in the polymerization unit with thermally cracked gases, and a light and a heavy cycle oil stream, both of which become charge for the thermal cracking coils. Naphtha from the crude column is reformed thermally and joins the other motor fuel components after treating.

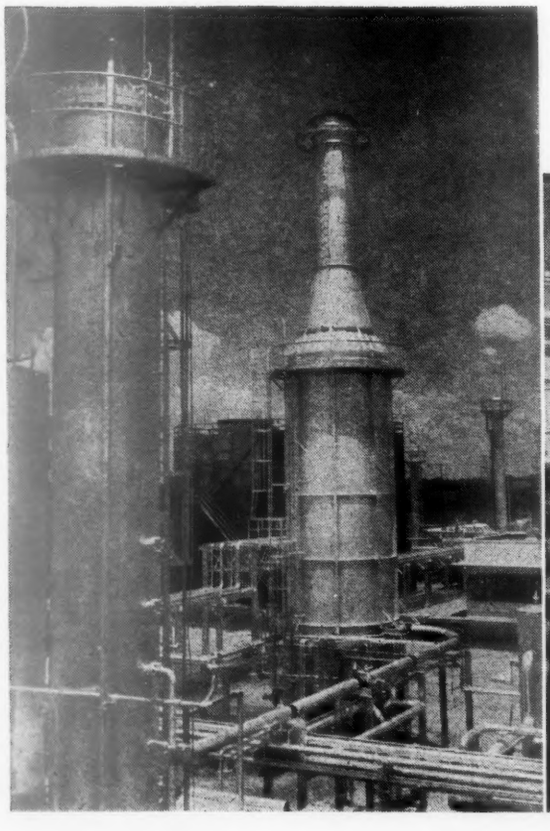
Treating of product streams includes the light catalytically cracked gasoline and the heavy catalytically cracked naphtha, and thermally cracked (and reformed) gasolines. All are washed with 20 deg Be. caustic solution and required quantities of UOP No. 5 inhibitor are injected by means of a Hills-McCanna proportioning pump.

Much of the production from the refinery, especially motor fuels, is handled by large tank trucks, all of which are loaded at a double rack in the east part of the plant grounds. Four 5000-gal tank trucks can be loaded simultaneously at each rack, and their daily activity is practically continuous. These racks are equipped with all the automatic filling and measuring devices and the safety precautions known to insure rapid handling and freedom from danger to plant or employees.

By these modernization steps this plant has been equipped with all methods for producing specialties and any refinery products to any specifications required to meet present or future market demands. * * *

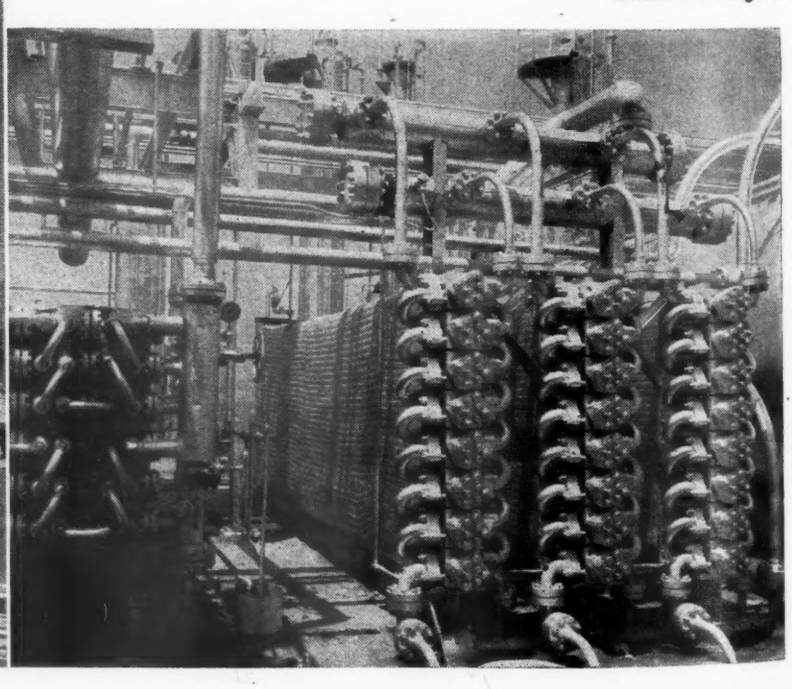


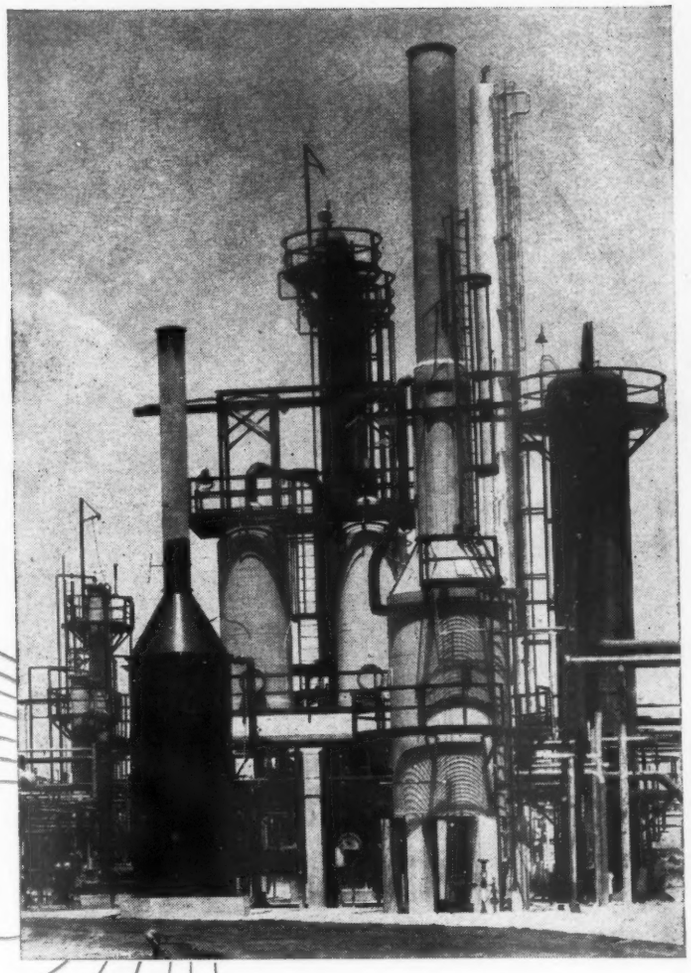
Electric switch rack at the catalytic unit.



Crude heater.

Crude exchangers.





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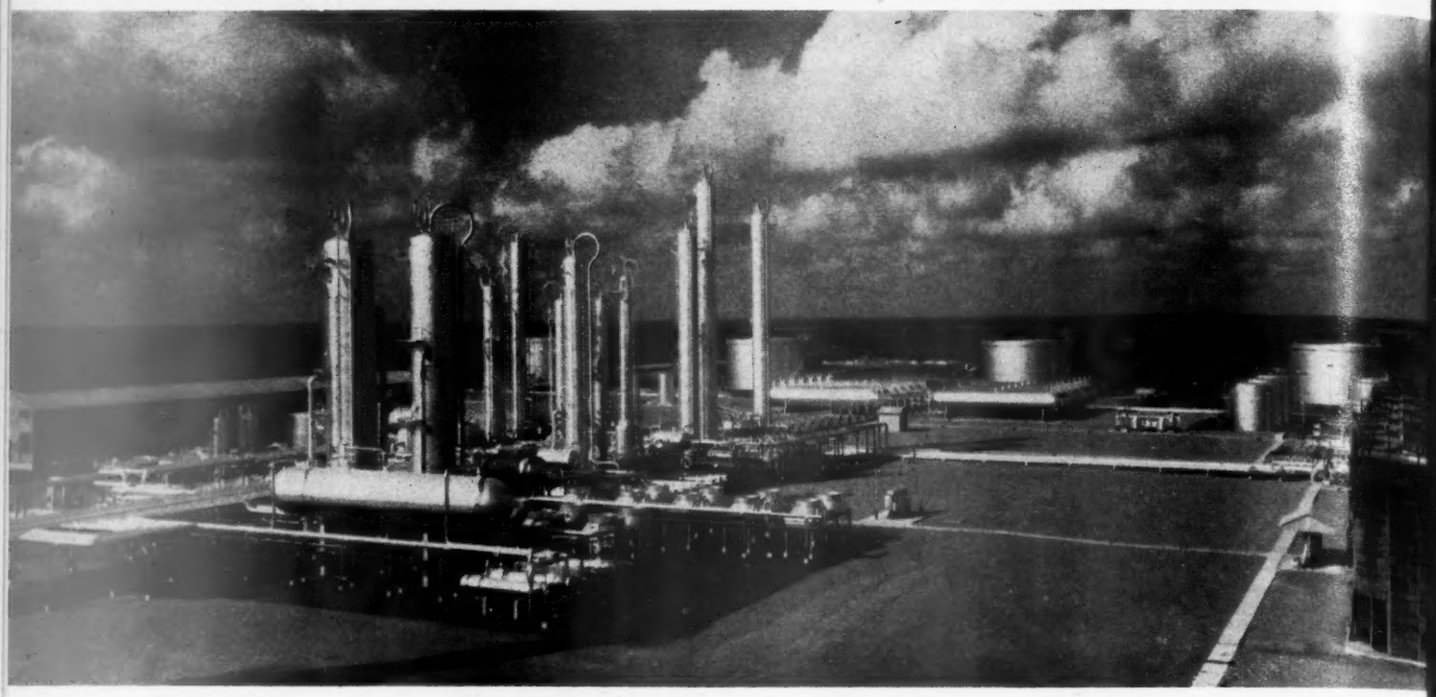

Overall view of the Burnell-North Pettus cycling plant as seen from top of water storage tank. Compressor building is at extreme left, process area is in center, cooling tower is in extreme right with product storage area in the background. Plant is five miles northeast of Pettus, Texas. Stanolind Oil and Gas Company operates the plant for the group of owners. Design and construction was by J & L Supply Company, Engineering Construction Division.

DESIGN OF GASOLINE PLANTS

PART 1—GAS AND GASOLINE PLANT LAYOUT

O. L. LEWIS*

THE major considerations in layout of any industrial plant, whether petroleum or otherwise, are safety of men and equipment, economy of construction, convenience in operation, and ease of maintenance. It is obvious that it is impossible to build and operate a plant with 100 per cent safety, zero cost of construction, complete push-button operation, and no maintenance. Therefore, plant layout is always an attempt to balance the above considerations to the best possible overall advantage. These primary considerations are affected by one group of basic factors that in general are beyond the control of the designer, and another group of design features that are within his control, all of course affecting the layout of equipment.

*C. F. Braun and Company.

Safety of Personnel and Equipment. Considering first the primary considerations mentioned, the major dangers to men and equipment are fire and explosion. It would be theoretically possible to design equipment in a plant so that fire could be prevented under any circumstances and so that all equipment were explosion proof. At this time, however, it would not be economically possible. It is the problem of layout to arrange the plant so that danger from these two sources are minimized as far as possible, using an economical basis for equipment design. As any fire or explosion is classed as an accident, layout should be such that in event of a fire in one portion of the plant, the possibility of spread to adjacent areas would be minimized. The layout also should be such that men working in an area where there is any danger of fire or explosion, have unobstructed and convenient passageway to leave the area fast. First-aid facilities should be placed out of any danger area but near enough to working area for easy accessibility. Facilities for fire fighting and control must be laid out for proper coverage for all plant areas, keeping in mind that their function is to minimize damage after an accident has occurred, and as such they must be placed out of any danger area and still be readily accessible for effective use within the danger area.

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Economy of Construction. In consideration of plant layout, economy of construction is usually next in order after safety of men and

equipment. Heavy critical foundations must be placed on suitable bearing soil in order to hold excavation, piling, and concrete yardage down. Areas should be situated to utilize existing grade to the best advantage to minimize cut and fill, which is expensive. Sufficient working room must be allowed for the erection of towers and heavy equipment. Sometimes it is desirable to arrange plot in such a way that spur tracks can be extended into the area so that compressors or heavy towers can be moved directly from rail cars to foundation without intermediate handling. This practice will many times obviate the need for expensive rigging equipment, as well as save a great deal on construction time. Units should be situated to keep pipe runs to minimum length and allow grouping of all possible lines. This will not only reduce amount of pipe required, but will make erection easier, simplify support, and facilitate access.

Convenience in Operation, Ease of Maintenance. Convenience in operation and ease of maintenance can be discussed as one catagory as many factors influence each to a great degree. Even economy of construction should at times be sacrificed in order to provide more desirable conditions for operation and maintenance. A plant is only built once but must be operated and maintained for years. Any inconvenience that results in increased maintenance cost or extra steps, or possibly confusion for the operator, should be avoided if at all possible as costs from these items continue and multiply with the years. Working space must be provided around all control valves, etc., for the operators' convenience. Adequate walkways free from obstruction, are a necessity. Control centers should be within a reasonable distance of operating equipment. Areas should be arranged to keep distances the operator has to walk to a minimum, and so far as possible, arranged in order of process flow to prevent back tracking in checking operation. Maintenance considerations require that space be left between equipment, and pipe runs so arranged that trucks or suitable handling machines may have free access to all equipment requiring servicing.

Basic Factors

The following basic factors all influence the primary considerations previously discussed and are in general beyond the control of the designer after the plant site is chosen. For that reason they are deserving of the earliest attention while plant sites are being considered as they influence to a large extent, the design features to be incorporated in the plant to be built, after site is chosen:

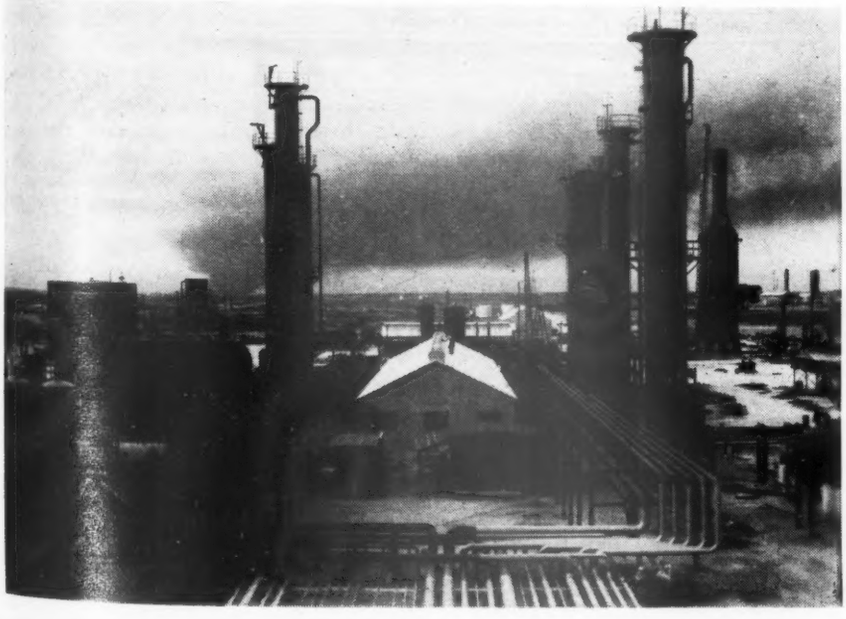
Topography. It is of course desirable that a plant site be reasonably smooth so that excess cut and fill is not required. In addition to the cost of grading on an uneven site, we are always faced with the extending of foundations to undisturbed bearing, which is very expensive in areas with excessive fill. It is desirable to keep in mind future plant drainage and waste disposal methods. The slope of the finished plant area should be such to give adequate drainage while maintaining a constant base line, (top of foundation,) in each unit. It is also well to remember that the drain system carrying hydrocarbon and water waste, will be most economically installed if gravity flow to point of disposal is possible. For that reason it is preferable that the plant site be somewhat higher in elevation than surrounding area so that closed drain systems may be advantageously handled. Another factor to be considered in final grading of a plant is that normal ground drainage runoff be such that any spill of inflammable materials from storage or process areas not be inclined to drain toward fires in fired heaters or boiler plants. It is also well to realize that some of the products from a plant of this nature are heavier than air under certain atmospheric conditions and will tend to concentrate in low places around the plant. This point should be kept in mind in arranging any fires or sparking equipment.

Shape of area available. The ideal place to locate a plant would be where topography would permit any desired arrangement and where no existing equipment, wells, etc., are close enough to affect the desired arrangement. Where this is not the case it is necessary to take into account the proximity of existing installations, some of which are possibly hazardous, and plant layout may be greatly affected by these factors.

Location of rail and access roads. Although compared to the investment in an average size recycling plant with gasoline recovery facilities, the cost of additional roads and piping from storage area to loading areas, is small. The natural location of rail and access roads is definitely a consideration in both choice of plant location and equipment layout within the plant after location is chosen. The primary points for consideration are location of office and truck loading areas within a reasonable distance of established roads and the proximity of rail facilities for both unloading equipment and loading product.

Prevailing wind direction. One of the most important factors in plant layout is the direction of prevailing wind. It is desirable to locate a cooling tower on the downwind side of operating areas in order to prevent spray from falling on personnel or equipment. It is not only inconvenient as far as personnel is concerned but quite costly when allowed to continually blow on exposed equipment. The normal corrosion rate from atmospheric conditions being greatly accelerated, with a resultant decrease in the entire plant life. It is also pref-

Plant arrangement with central pump house and control room. The general plant arrangement is the same as shown in Fig. 1.



erable that any fires such as boilers or fired heaters, be located on the upwind side of the plant so that normally any gas or vapor leakage within the processing areas will blow away from the fires rather than toward them. The same reasoning applies to the location of a compressor building with respect to light ends processing equipment, in that most gas engines have some source of spark that cannot be entirely protected and inflammable gases in sufficient concentration are apt to be ignited by such a source. For that reason it is also important not to put any gas engine drivers on the downwind side of the plant although there are probably other items of equipment with a higher priority on the direct upwind location so that a compromise is usually reached on the location of the compressor building itself.

Climatic conditions. The climatic conditions encountered in the proposed plant location must be considered in plant layout, to take into account the effects of heavy rainfall, heavy snow, and high and low temperatures. An area of heavy rainfall will naturally require more gradient for satisfactory drainage than one in an area of little precipitation. The effect of snow and wind is probably less critical but if either is apt to be present in excess, it should be taken into account in spacing of buildings and operating areas in order to increase operator comfort as much as possible, and in some instances, equipment should be more widely separated to allow room for machinery to be used in clearing operating areas of snow. It is preferable in an area where icy conditions are apt to exist any portion of the time, that equipment and operating valves be kept at ground level so that slick operating platforms do not have to be contended with. In areas where humidity is relatively high or wind velocity usually low, air fin coolers and operating buildings should be situated to take maximum advantage of natural ventilation.

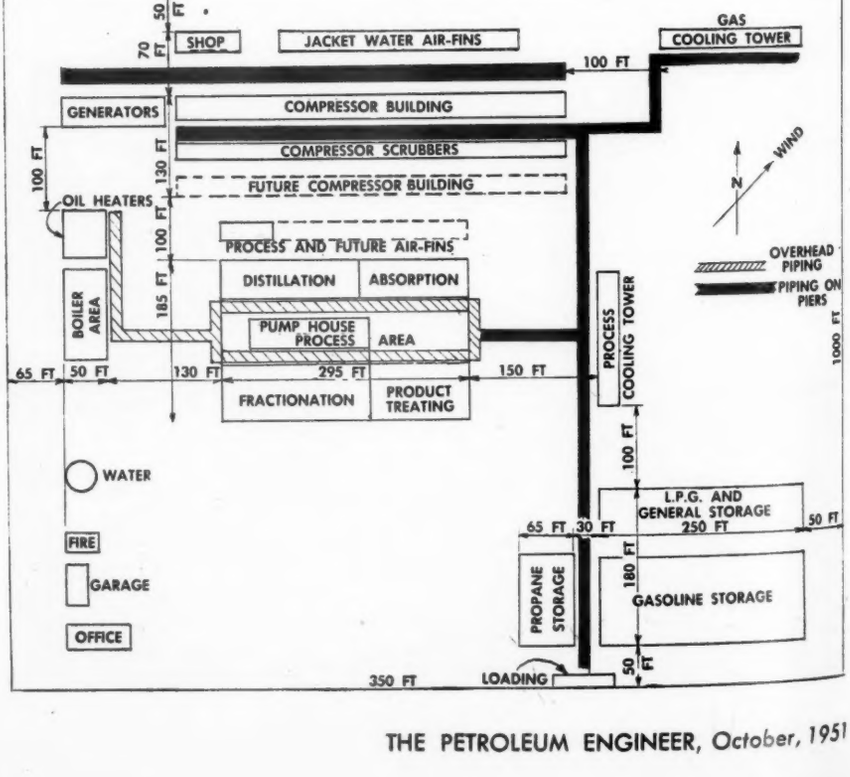
One other factor in this same category to a certain extent, is insurance requirements on equipment spacing and their effect upon insurance rates. The spacing in general, set up by insurance companies, is based upon the same factors that have been considered under "Safety of Personnel and Equipment," and although they are an excellent guide and should be kept in mind in equipment location, it is usually found that a plant layout with recognition given to the primary considerations discussed in this paper, will be acceptable under insurance company regulations. In case there are instances where a difference in spacing of 5 or 10 ft would increase or decrease the insurance rate, many times it is possible to accommodate such change to the layout when the insurance regulation is known and taken into account.

Design features. The design features of a plant are often materially influenced by existing basic factors discussed above. With this influence in mind it is the aim of the designer to approach as near as possible, the ultimate in safety and economy. Some of the major design bases affecting layout, are as follows:

(a) *Method of Cooling* — Three common cooling arrangements are encountered. There is the centralized system where open sections are placed in the cooling tower and cooled directly by contact with the water. This system involves piping of all material to be cooled to the cooling tower and back to source. Another plan more widely used in recent years, is the closed system in which the cooling water from the tower is pumped to tube and shell exchanger units located where the exchange is needed, and the water returned to the tower for cooling. This system requires more space, particularly in process areas, for the location of exchanger units. However, the location of the cooling tower relative to the process areas is not as critical as it is less expensive to pipe the water to and from the tower than it is to pipe each separate hydrocarbon service to and from the tower. Direct air cooling through the use of air fin units where process material is circulated through coils which are cooled by fans, is coming more and more into use, particularly in compressor station work. As far as piping is concerned, the air fin system materially reduces the amount of piping required as the units themselves may be located relatively close to the source of material to be cooled and no cooling water piping is involved. As there is no spray problem from these air fin units, that is one less thing to be considered in their location.

(b) *Pump Grouping* — The arrangement of pumps has a distinct effect upon proposed plant layout. When the pumps are grouped in one central pump house, it is necessary to split the rows of equipment and therefore the stanchion runs of piping on either side of the pump house in order to keep suction lines as short as possible and to prevent excessive piping costs. When pumps can be located outside without protection, they will normally be placed adjacent to the equipment from which they are taking suction and thus spread out the major equipment which usually will require a longer process area but not necessarily one covering any more square feet than if the pumps were centrally located. A variation of the last arrangement is to locate pumps in a separate line across a walk space from the major towers. This plan will normally allow the towers to be spaced on the same centers as required with a central pump house, without tying down the order of equipment so rigidly. The suction lines will generally be slightly longer than would

FIG. 1.



be the case with strictly local pump location, but both suction and discharge lines normally much shorter than is possible using a central pump house arrangement.

(c) *Instrumentation* — Where strictly local instrumentation is used there is little problem in layout and it is hardly a consideration. When it is desirable to group instrumentation for a unit on individual boards, and protect with a shed or small building, room must be provided for these facilities. If it is possible to have one central instrument board located in a control building, it is normal to locate this building as centrally as possible within the area it is serving. Where a central pump house is used, it is common practice to provide control room space in one end, thus necessitating one building rather than two.

(d) *Future Equipment* — Unless provision has been made in the original layout of a plant for the addition of future equipment, it is always difficult to add such equipment should it be desired at a future date. Even if it is not contemplated that certain units ever be installed in a plant or that its size ever be increased, it is still good sense and usually much more economical in the long run, to keep in mind the possibility of such additions at the time the original plant is laid out. so that a layout is not arrived at which is practically impossible to add to. The most common additions encountered are additional compressors, due to increase of volume of gas available; additions to cooling towers; addition of gas treating units; addition of product treating units. Although space for such units mentioned is not actually designated on the original layouts, the person responsible for plant layout should always keep those space requirements in mind and so far as possible, arrange his existing equipment so that additional units can be added without exceptionally great expense in removing existing facilities.

To illustrate the influence of the factors discussed, two figures are shown of basic layout covering plants built in recent years.

Fig. 1 shows the basic arrangement of a compressor and gasoline plant which is fairly typical of one type of construction. Only dimensions which are critical to basic layout are shown. In this plant air fin coolers were used for compressor and generator water cooling and for still overhead cooling. A spray cooling tower with open sections was used for compressor gas cooling. The process cooling tower also used open section cooling. Pumps were located in a central pump house with major instrumentation on a board in this pump house. Provision was made for the addition of a future compressor installation identical to the one installed originally. All area needed was available. The plot was fairly level, being slightly lower in the southeast corner so that general plant drainage was in that direction. There was not enough slope so that closed drain systems could have normal run-off. The hydrocarbon drain system was run into an underground storage tank and pumped outside of plant limits for disposal. Truck loading of products was to be used and the truck loading area was located immediately to the south of the gasoline and propane storage, the road to this loading area coming directly in front of the office building. The plant was located in Southwest Texas, with a southwest prevailing wind. It will be noted that the product storage areas are on lower ground than the remainder of the plant. The boiler area and oil heaters are located in the higher end of the plant. There is a minimum of 100 ft allowed from any fire or source of spark to the process area. Drift from both cooling towers is away from the working area of the plant. Any vapors lost in storage or process areas will normally blow away from fires or any source of spark. Actually, it would have been slightly more desirable for the process area of this plant to have been further to the east so that prevailing wind from it was not toward the end of the compressor building. Other considerations were sufficient in this instance to override this point. The shop, primarily for servicing compressor and generator equipment, is located adjacent to that equipment.

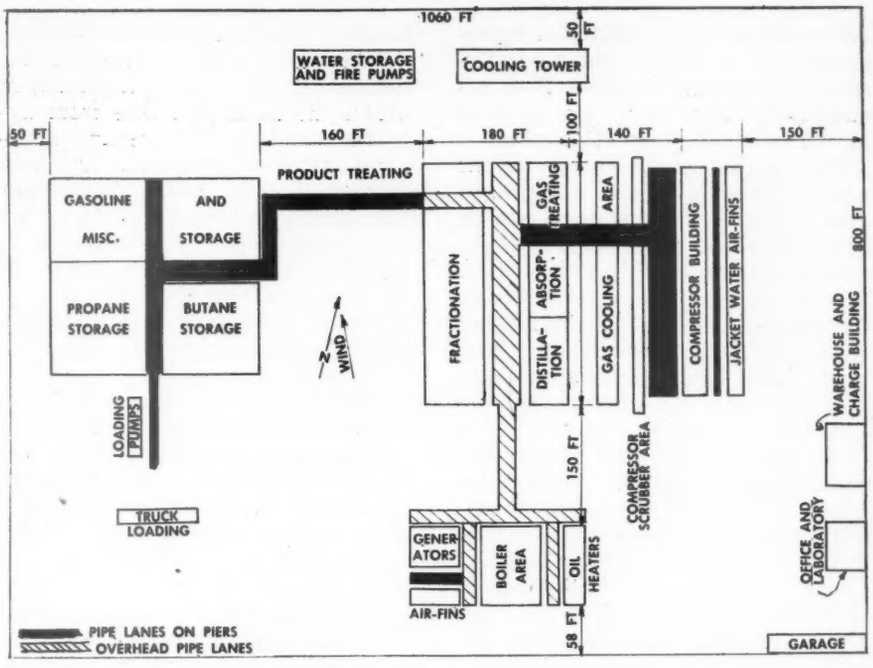


FIG. 2.

The plant is open for truck access from the west between all rows of equipment. The absorption equipment is located in the northeast corner of the process area to shorten lines coming from the compressor area in pipe run from the gas cooling tower. The distillation equipment is located in the northwest corner of the process area in order to shorten the transfer lines to and from the oil heaters located in that direction. Fractionation is across the pipe lane in the southwest corner of the area as near distillation as possible, and as most of the pumps in the unit are with either the distillation or fractionation areas, they are as close as possible to those areas, using this type of layout. The product treating is in the southeast corner where piping from the fractionation section can go directly by it on the way to storage.

Fig. 2 illustrates another plant of approximately the same type but with different basic factors and design features from the plant illustrated in Fig. 1. The effect of these features upon layout can be seen by comparison. In this plant compressor and generator jacket water cooling was with air fins. All other cooling was by closed system with exchangers located in the processing areas and water piped to and from the cooling tower. Pumps were located outside in a row, parallel to the rows of major equipment. Instrumentation was grouped for each processing unit and located in line with the pumps. No definite request was made for provision of future equipment; however, it will be noted that the compressor building, cooling tower and storage

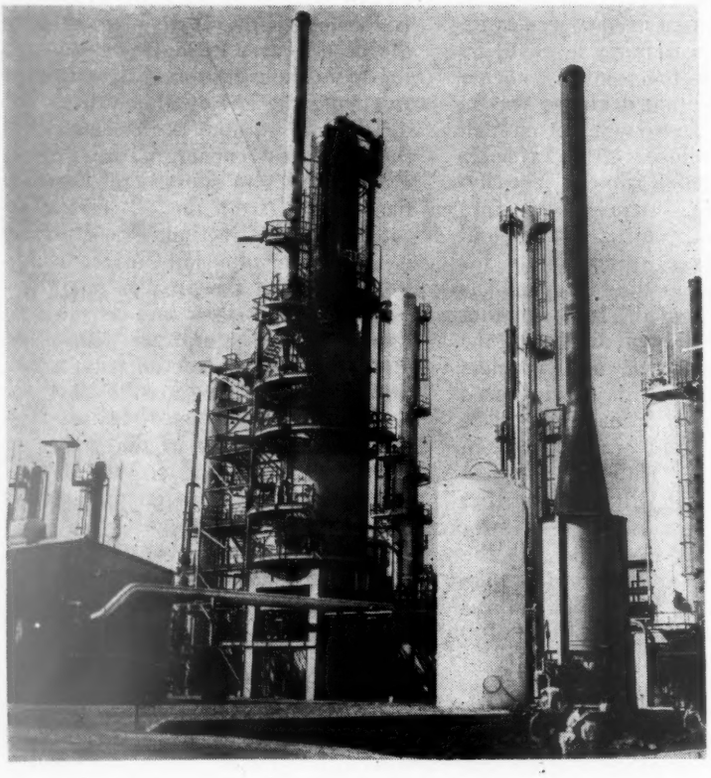
are so located that additional equipment could be added without interference with existing facilities. Both gas and product treating are incorporated in the original plant. This plant is slightly higher in the vicinity of the process area with the compressor area, boiler area and storage area all being at about the same elevation, somewhat lower than the process area. It was possible in this plant to run the drainage system to a skimming basin located in the northeast corner of the plot. Truck loading was also used in this plant, with the road to and from the truck loading area going to the south of the plant proper. The prevailing wind in this instance was from the southeast. The same considerations in layout were involved here as in the plant shown in Fig. 1. The gas treating area was located alongside the pipe run from the compressor building to process area, absorption across the pipe lane from gas treating, distillation in the southeast corner, again to shorten transfer line distance to oil heaters; fractionation across the main pipe lane from distillation and product treating so located that flow is a straight line from fractionation to treating to storage. The storage in both instances, is laid out so that propane and butane tanks are closer to loading pumps than the gasoline area. In hot summer weather this is at times an advantage in preventing vaporization at the time loading pumps are started.

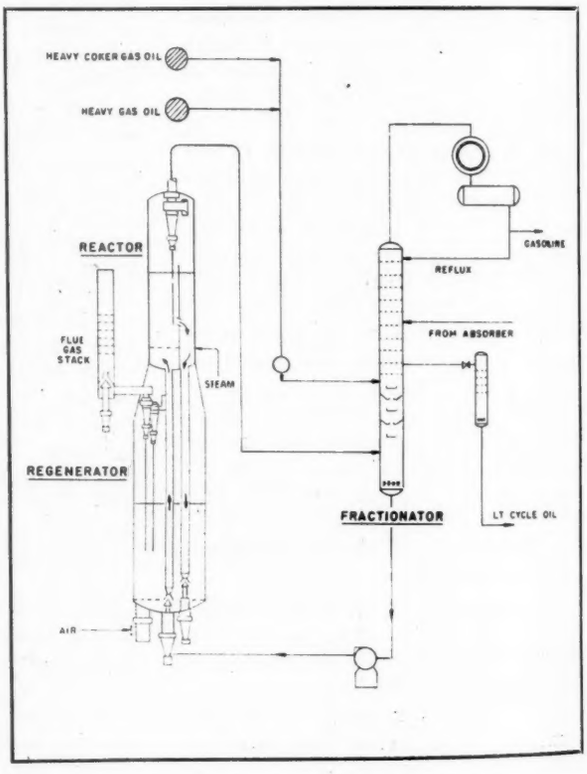
When each of the factors discussed have been given proper consideration in basic plant layout, it is quite easy to go on from basic overall layout to equipment layout in the individual areas without encountering great difficulty. Both of the plants illustrated were economical in construction, have been reported as convenient for operation, and although no major maintenance has yet been required, operators are satisfied that sufficient room has been provided in all instances for proper servicing of equipment. It will be noted in both plants, sufficient room has been left inside the plant fence for roadways or moving in or out of heavy equipment. All major equipment in both plants can be reached without crossing over or under pipe lanes with trucks or servicing equipment.

The real tests for acceptability of plant layout are satisfaction to the contractor through economy, satisfaction to the owner's executives through attractiveness and uniformity of arrangement, satisfaction to the operators through convenience and safety, and satisfaction to the maintenance department by provision of basic maintenance facilities and general maintenance convenience. ★ ★ ★

Part 2 will be published soon.

First Orthoflow Unit Put on Stream in Canada





In the accompanying photo and diagram are shown construction and internal details of the world's first Orthoflow Fluid catalytic cracker, recently put on stream at Edmonton, Canada for the British American Oil Company, Ltd., by The M. W. Kellogg Company, refinery and chemical engineers of New York City. The unit, designed by the American firm, was erected by its subsidiary, The Canadian Kellogg Company, Limited.

This Orthoflow is designed to process about 2000 bbl per day.

Aside from the fact that the Orthoflow is a single-vessel unit containing chambers for reaction, regeneration, and stripping, the most important design innovation is seen by Kellogg in the straight-line catalyst carrier lines, which are within the vessel. The lines will be much less subject to erosion by high velocity catalyst than bent lines. Another economy and low-maintenance feature of the design is the elimination of expansion joints in the lines.

To absorb the natural thermal expansion of the carrier lines, Kellogg spring-loaded the specially designed catalyst-and-oil-flow control valves. The valves themselves are quite a deviation from the slide valves that control the flow in the majority of Fluid crackers erected to date. In essence, they are large needle valves through which catalyst and oil are introduced to the carrier line leading to the reactor. Hot catalyst from the bottom of the regenerator is drawn into the line by pressure drop created by high velocity oil passing through valve. ★ ★

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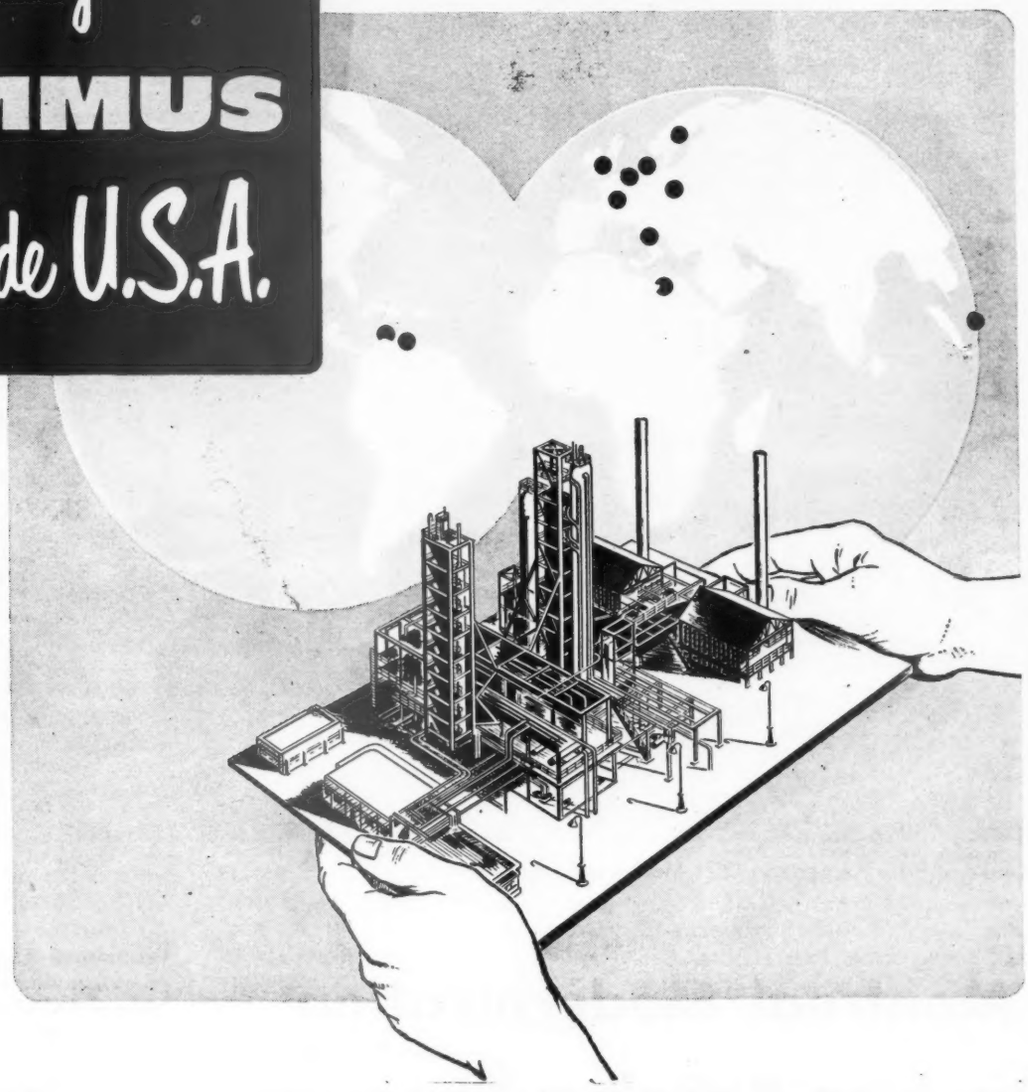

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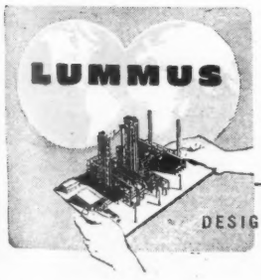

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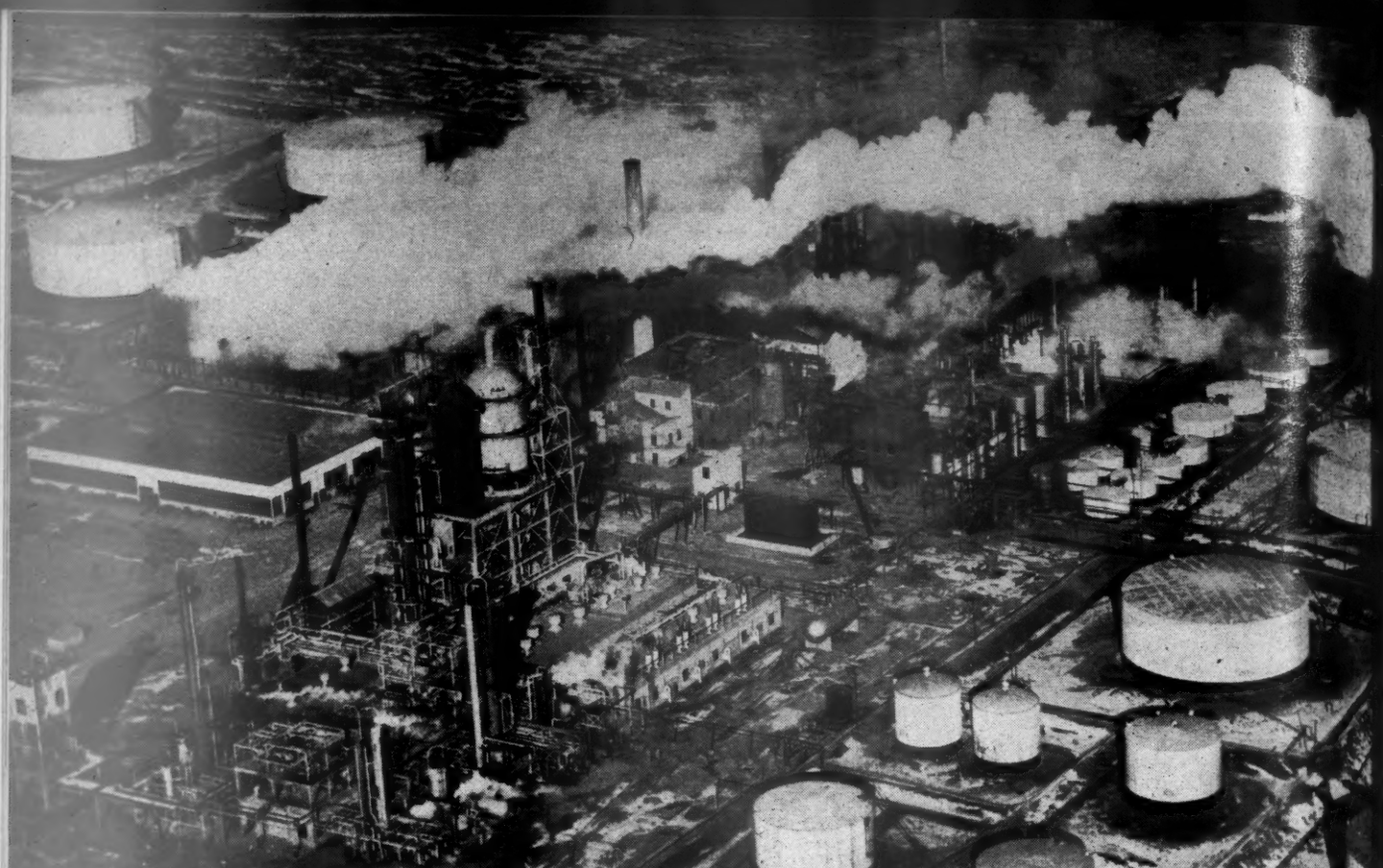


Aerial view of British American Oil's Montreal East refinery.

P 721.34

Montreal Modernization Doubles Refining Capacity

Fluid cat cracking and polymerization, other innovations employ special design features

HARRY CHAPIN PLUMMER

CANADA'S first topping and decarbonizing unit, one of a three-fold plant comprising also a jointly operated Fluid catalytic cracking and catalytic polymerization unit, figures as an outstanding acquisition in the lately completed expansion of British American Oil's Montreal East refinery in the Canadian metropolis. Production capacity has been more than doubled by the improvement.

The expansion program developed not only the combination of cracker, poly and gas recovery, and other permanent installations, but numerous processing innovations in the form of heat-conserving and cost-saving operations unique in Canadian refinery practice.

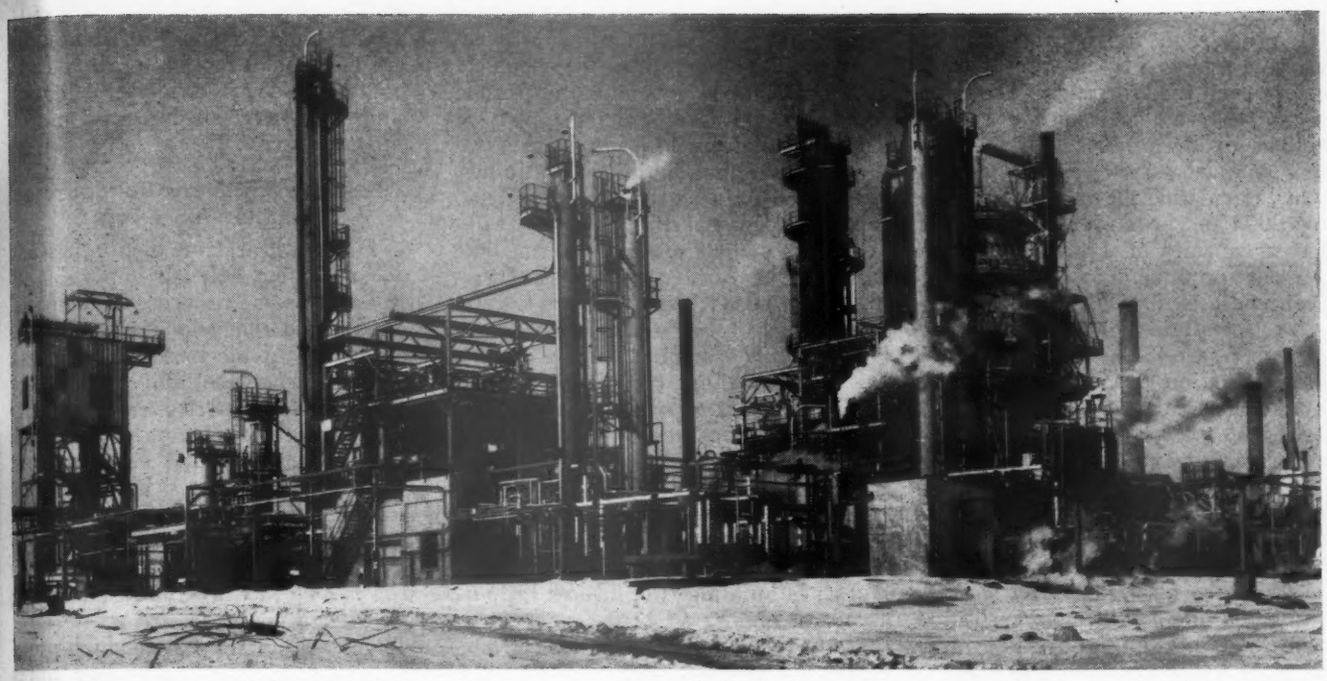
Apart from the structural departures, the building of the imposing layout entailed certain techniques and procedures new to Canada. To cite one example: The placing of a 117-ft 163-ton fractionating tower in an upright position, one of the biggest single "lifts" ever undertaken in Canadian construction. Another, the designing of all building bays to the uniformity of 13 ft 4 in. That paid off by permitting a single set of forms to be used throughout all building in the area. Still another, the erection of an indoor pipe-bending shop on location. There 75 miles of steel pipe, figuring in the expansion operations, were treated.

EXCLUSIVE

400 Per Cent Throughput Rise Since 1931

Montreal East was opened 20 years ago with an initial capacity of 8000 bbl. In 1938, as a crude and vacuum distillation unit and thermal cracker, with concommitant utilities and other standard equipment, its daily production was brought to 17,000 bbl. The latest capacity rating is 40,000 bbl.

World War II had strained the refining capacity of The British American Oil Company Limited, the Canadian owning corporation, to the limit. Increased requirements of indus-



Immediately in front of cracker are absorber and stabilizer towers of gas recovery section. To the left are two vessels of the H_2S removal unit. Farther left, overshadowing the caustic scrubber and water wash towers, is the tallest of the group, the 98-ft depropanizer tower, which removes some of the paraffinic fractions.

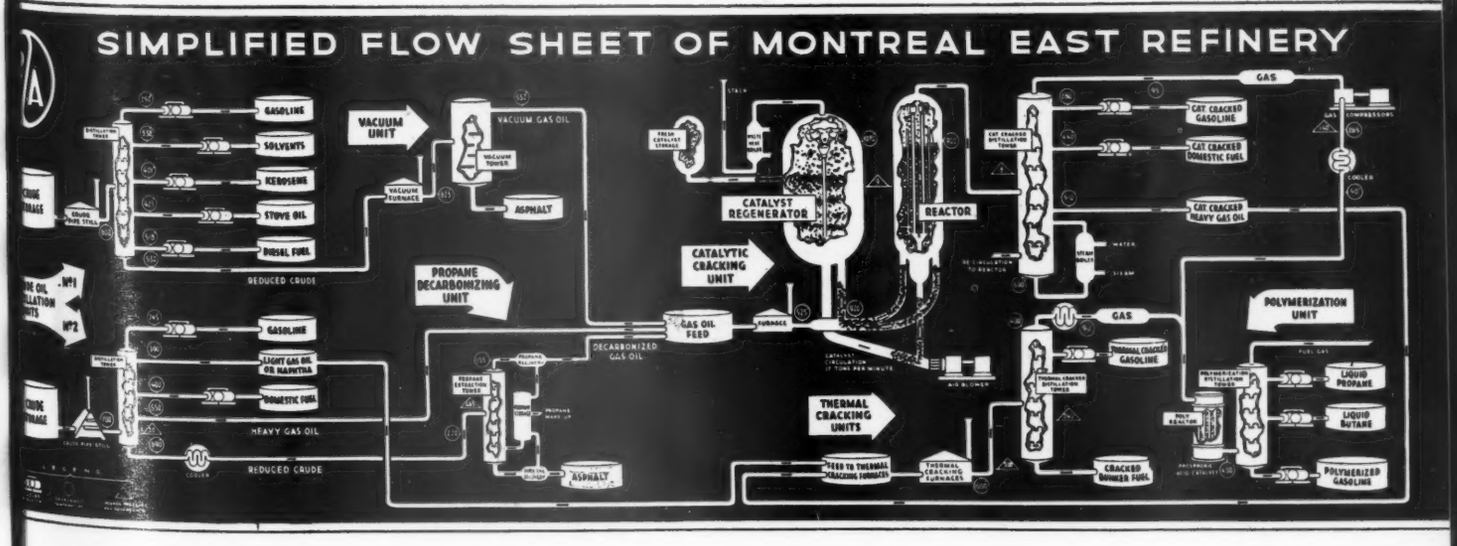
try in this country and the mounting utilization of domestic oil heating indicated an unprecedented post-war rise in petroleum consumption. Modern automobile engine design brought into play higher and higher compression ratios for maximum performance and fuel economy. To operate such engines efficiently called for high octane gasoline that would have to be continually improved in relation to engine development.

Redesigning of the entire electrical system was a measure essential to the most effective distribution of the 47,600 kw hours daily consumed. A potential, that, sufficient to supply the domestic requirements of a community of 10,000. Similarly the network of insulated lines delivering steam to the various processing units within the refinery precincts had to be re-charted along with the feed supply of cooling water, compressed air, fuel oil, and fuel gas required for plant operation. Wastage of water has been avoided by circulation over a fan-equipped cooling-tower constructed of California redwood. Water used to cool hot products as they leave the units becomes heated and must be cooled so that it can be used again. Four large pumps carry it through the cooling-tower, which has a capacity of 24,000,000 gal per day.

Cabinet Officials at Dedication Ceremonies

The giant construction job was completed late in 1949, and in May 1950 W. K. Whiteford, president of British American, was host, in impressive dedicatory ceremonies, to Honorable Robert H. Winters, Minister of Resources and Development of Canada; Honorable Paul Beaulieu, Provincial Minister of Trade and Commerce of Quebec; Mayor Camillien Houde, of Montreal; Mayor Napoleon Courtemanche of East Montreal, and other dignitaries of state, finance, and industry.

In the new "cat cracker" the process of converting high boiling point oils into those suitable for gasoline engines is facilitated by the use of a natural clay catalyst reduced to a very fine freely circulating powder to hasten the chemical reaction of cracking. The carbon from the oil undergo-



ing processing, which coats the catalyst, is removed by burning and the catalyst returned for re-use. The burning of the catalyst requires a great volume of air produced by a blower that can deliver 60 tons of air per hour, circulating the catalyst at a rate of 1000 tons per hour. The cat cracker has a capacity of 13,500 bbl of oil per day, producing gasoline, furnace-fuel, and gas-oil.

The catalytic polymerization unit produces gasoline by catalyst-assisted polymerization of gaseous materials by the chemical union of two or more light molecules to form single heavier molecules. It brings into high relief one of several novel methods that have been adopted at Montreal East to squeeze out the value of by-product heat. That is in the use of hot oil product from the fractionator for heating and re-boiling in the polymerization unit. Another example: The hot slurry from the bottom of the fractionator is employed for re-boiling heat in the gas recovery system, while another exchanger converts the excess thermal energy of that oil-catalyst mixture into steam. Yet another instance is the conversion of heat to steam by use of a tubular boiler at the regenerator outlet, thus providing energy for driving pumps and blowers.

Avoids Heat Loss Through Intermediate Storage

In raising the capacity of the Montreal East refinery, Canadian Kellogg Company Limited, to which was entrusted the designing of the expanded plant, installed a combination crude topping and decarbonizing unit from which hot feed flows directly to another combination unit (the jointly operated fluid catalytic cracking and catalytic polymerization unit) without loss of heat through intermediate storage. A further saving is thus realized in that it eliminates pre-heating in tanks to facilitate pumping during the cold of Canadian winters.

Both of those combinations have common control rooms, the two catalytic units operating off one and the feed preparation units off the other. Just those two instances are sufficient to demonstrate that operating personnel are kept at a minimum and that there are obvious savings in material costs in building two, instead of four, control rooms.

Above and beyond the material savings due to combining the processes, another slash in the initial construction cost came in the overall pumping installation. Two factors had to be considered: The refinery has its site on solid rock and the frost-line is five feet below the surface. Obviously the blasting of sub-level passageways would have meant excessive outlay. Yet the alternative, of installation of a complete overhead water system, was not without its posed problems. To meet those the Canadian Kellogg Company employed special insulating techniques and, where possible, designed piping systems so that fluids are in constant motion to avoid freezing. Where deadends made that impossible pipes were steam-traced and insulated heavily.

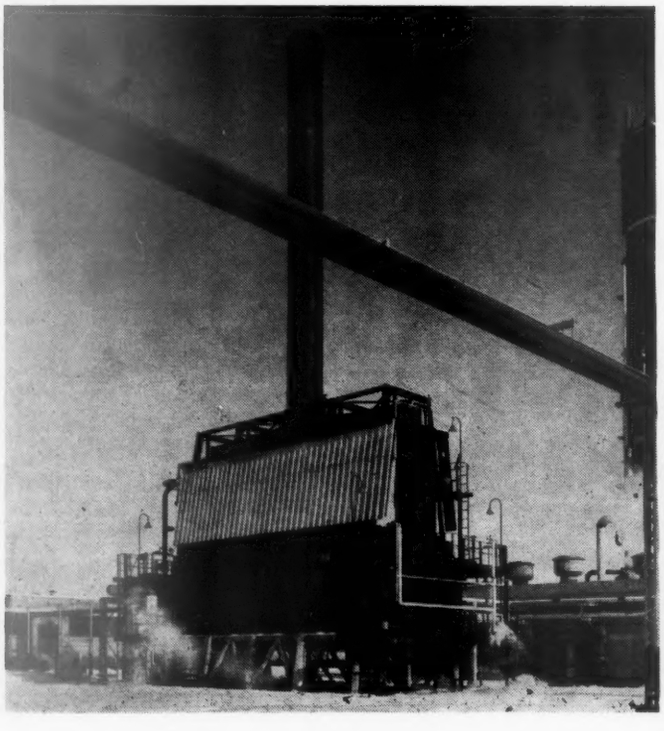
Propane Recovery Condensers Smaller, Cost Less

The combination distillation and decarbonizing unit has important advantages; some resulting from special designs and others coming as a natural outgrowth of the unit's compactness. One instance; the propane recovery system is designed to operate at higher pressure than is commonly used. Hence the propane condenses at higher temperatures, with the end result that condensers are smaller and less expensive. From the recovery system the propane flows to storage tanks for re-use in the asphalt-removing process.

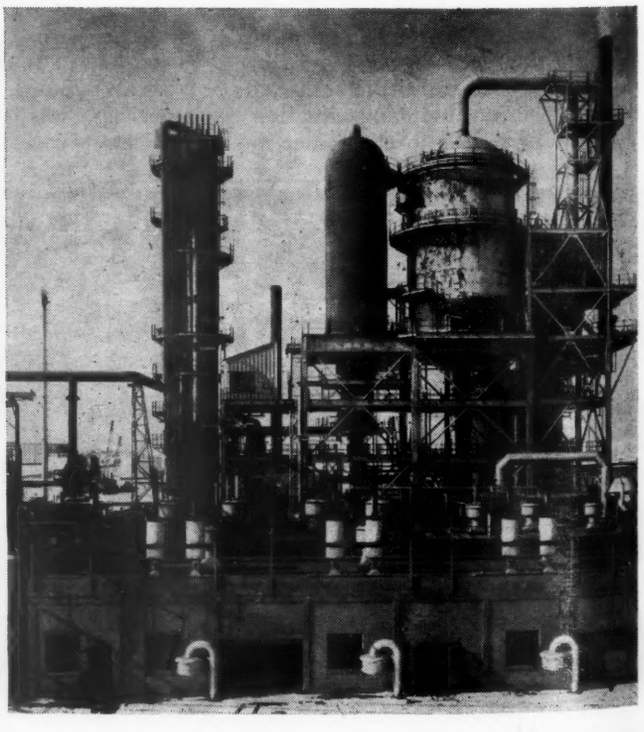
One reason for having high-pressure pumps in the decarbonizing unit is to make it adaptable to the preparation of lube stocks when desired. Both steam and electric pumps are provided with the steam units on a stand-by basis.

Not a few of the combination's benefits are realized in the control room, by employing one set of operators during each shift, and by the use of a common utility system. Physical proximity of the two processes naturally reduces the volume of piping and indirectly makes the conservation of usable heat an easier design task.

Topping and decarbonizing unit of Montreal East refinery—crude furnace (note flare line running across picture in foreground).



Cracking unit showing compressor house in foreground and (left to right) fractionator, reactor, and regenerator vessels.



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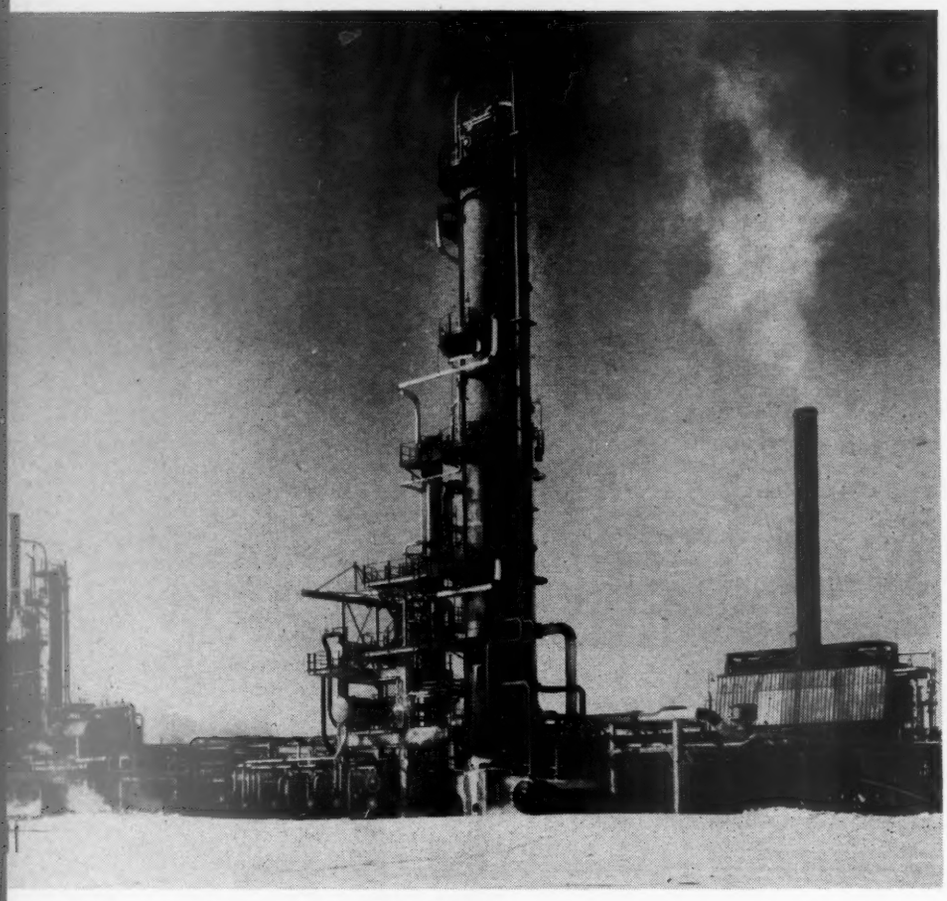


Topping and decarbonizing unit at Montreal East refinery with crude tower at center and crude furnace at right.

The charge rate of the topping unit is 14,500 bbl per day of East Venezuela crude, with 4350 bbl per day going into the decarbonizing unit, which produces 3480 bbl per day of catalytic cracking feed. Residue from the decarbonizing unit is cut-back with heavy cycle oil to make fuel for refinery heaters. This feed preparation capacity, in addition to that of the existing combination thermal section, which is completely integrated into the present set-up, brings the total feed available for catalytic cracking to approximately 13,500 bbl per day, yielding in the neighborhood of 6000 bbl per day of 400 F endpoint gasoline for blending with natural, thermally cracked, and polymer gasolines from new and old units.

Mechanical Design "Tailored" for British American

On the major units, several improvements in mechanical design have been incorporated to keep initial costs down. On the cracker the precipitator has been eliminiated, primarily because the bettered design of the regenerator cyclones keeps the natural catalyst loss at a negligible minimum. The small volume of catalyst that is lost with the flue gas is less than that that must be replaced to maintain proper selectivity. Although the spent catalyst stripper, integral with the reactor, is now recognized as a standard Canadian Kellogg Company Limited feature, the elimination of the catalyst recycle boiler in this unit is a new development, "tailored" to meet British American needs. Such a variation, while it would limit flexibility of the unit for some operations, lowers the investment cost markedly by cutting out one sizable expensive vessel.

In the gas recovery section, no particular changes have been incorporated with the exception of "borrowing" the cracker fractionator for distilling vapors that contain absorbed gasoline. Again, that meets the particular requirements of the B-A plant. It might not be adaptable to many other refineries.

The poly reactors are designed to charge 1428 bbl per day of light fractions that have been treated in the H_2S removal unit. Following the reaction, light ends such as propane, ethane, and butane are removed in standard fractionating columns. Propane goes to LPG sales and as make-up feed for the decarbonizer; lighter gases are used to drive gas-engine-operated compressors in the recovery system, while the butane is naturally employed for vapor pressure blending of gasoline.

Due Allowance for Higher Octane Levels

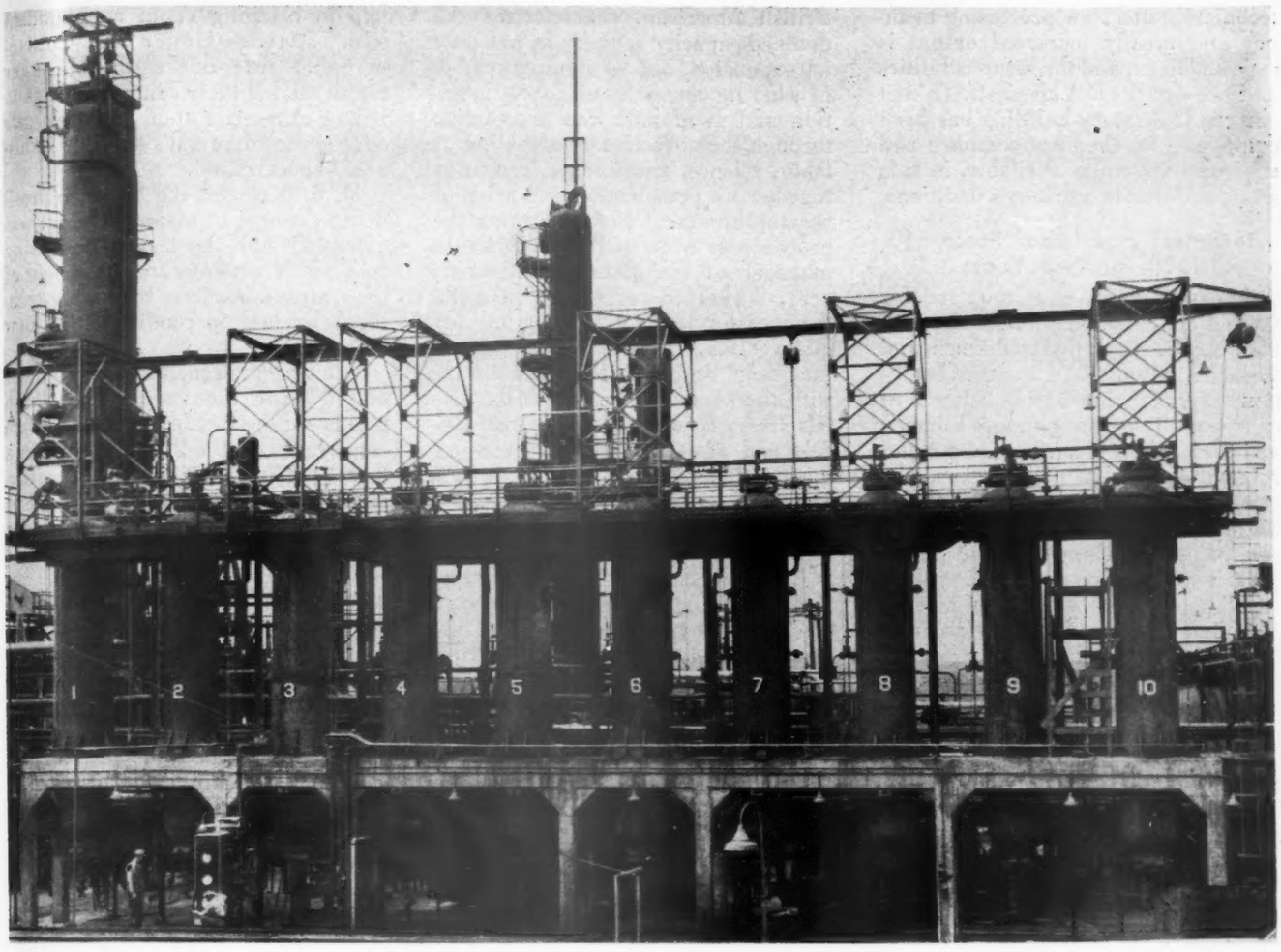
In engineering the new plant, the Canadian Kellogg Company Limited provided for certain increases in the amount of equipment to meet foreseeable demand for higher octane levels than are now necessary. Provision has been made for two more poly reactors should market factors render them desirable. The use of synthetic catalyst and higher operating temperatures in the cracker could readily produce the additional light-ends charge stocks without any mechanical alterations.

Important as are the construction savings that have been developed, they are overshadowed by the scrupulously careful engineering of the new units and their equally painstaking integration into the existing refinery, both of which resulted in exceptionally high conservation of process-developed energy. Particularly is that apparent in the process heat system. Of course, the normal uses of heat exchangers for the purpose of producing process steam and conserving thermal energy are more than familiar to all processors. But the combination units at Montreal go beyond that. For example: With the exception of the furnace for the feed preparation unit and that for the fluid cracker, no major additional heating sources are required in the units. Furthermore, in the case of the cracker the fuel requirements are drastically reduced by piping hot feed from the topping-decarbonizing equipment, the thermal cracker and the vacuum flasher directly to an accumulator, whence it is fed immediately to the cracker heater.

Economy in Thermal Energy Expenditure

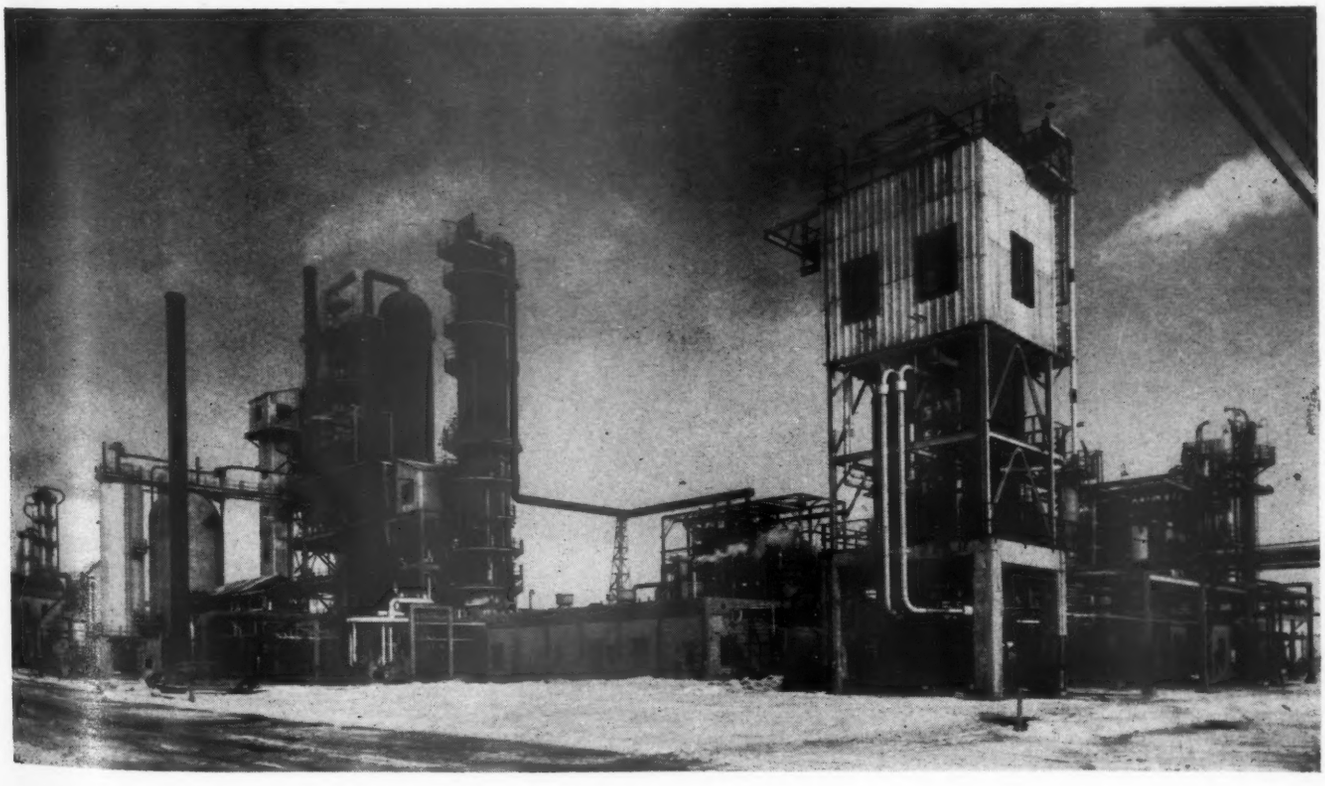
At the accumulator, the average temperature is around 325 F, combining heavy vacuum gas oil at 400 F, a stream of light vacuum gas oil at 150 F, decarbonized gas oil at 250 F, intermediate virgin gas oil at 350 F, and heavy virgin gas oil at 450 F. This mixture is heated to 524 F, before entering the catalytic reaction zone. Considering that the normal temperature of feed from storage tanks runs about 110 F and generally requires some pre-heating by coils in the tanks to reach even that temperature level before pumping, the thermal energy saving is apparent.

A corrollary to the expansion development at Montreal East was the erection of a new administration building of ultra-modern architectural lines and appointments and a new laboratory building. Radiant heating is a feature of both structures and a fully equipped cafeteria is provided in the former for the comfort and convenience of the administrative and



Line of 10 catalytic polymerization reactors at the British American refinery.

Catalytic cracking and catalytic polymerization units of British American Oil's Montreal East refinery—right to left, catalytic polymerization reactors, main catalytic cracker structure, catalytic cracking heater, and catalyst storage drums.



technical staffs. New processing methods and greatly increased output is expected to expand the responsibilities and work of the B-A chemists. To that end the laboratory building has been equipped with the most complete and advanced apparatus available, in safe and comfortable working conditions.

Technical and Labor Force of 1500 for Two Years

Almost 2 years were required for the big construction job. As many as 1500 engineers, skilled tradesmen, and workmen struggled in weather conditions ranging from 20 deg below zero to above 95 deg, in gale and blizzard and the protracted spring and autumn rains of the St. Lawrence Valley. The variety of equipment required included more than 50 welding machines, several cranes, topped by one with a capacity of 75 tons, 17,500 tons of concrete, and 75 miles of steel piping. Although an army of technicians and labor was recruited for the work of construction, slightly less than half a thousand employees are now operating the new equipment, with its daily throughput of 635,000 gal of high quality gasoline—enough to drive a fleet of 2174 automobiles from Montreal to Vancouver and back.

At the dedication ceremonies, for which a party of editors flew over from Toronto to join newspaper and magazine motor reviewers from all over Canada, President Whiteford, of British American, characterized the doubled-capacity refinery as not only an expansion, but "a shining symbol of what modern man of honest intention and good faith can accomplish through the collective contribution of labor, science, and finance, cemented together by perspiration and pride of accomplishment." Before turning the proceedings over to R. F. A. Smith, manager of the Montreal East refinery, Whiteford remarked that while the occasion was a gratifying one for all of "B-A," it was particularly so for "Bob" Smith, who, after 16 years with the company, "now has the satisfaction of heading one of the biggest and most modern refineries on this continent."

Ottawa Spokesman Sees 10,000,000 U. S. Dollar Savings

J. Gerald Godsoe, vice president, introduced Cabinet Minister Winters, of Ottawa, who told the dedication assemblage that the new plant "will be producing petroleum products in Canada that otherwise we would have had to purchase abroad. Annual savings of U. S. dollars may be something in the order of $10,000,000. Such expansion is symbolic of the spirit of enterprise that has made and is continuing to make Canada a prosperous land." Quebec's Trade and Commerce Minister Beaulieu, following, declared that "this Province believes that such enterprise is better than any other system in bringing about an abundant life." Mayors Houde and Courtemanche, introduced by Manager Smith, added their congratulations to British American upon the huge-scale addition to Montreal's premier industrial concentration.

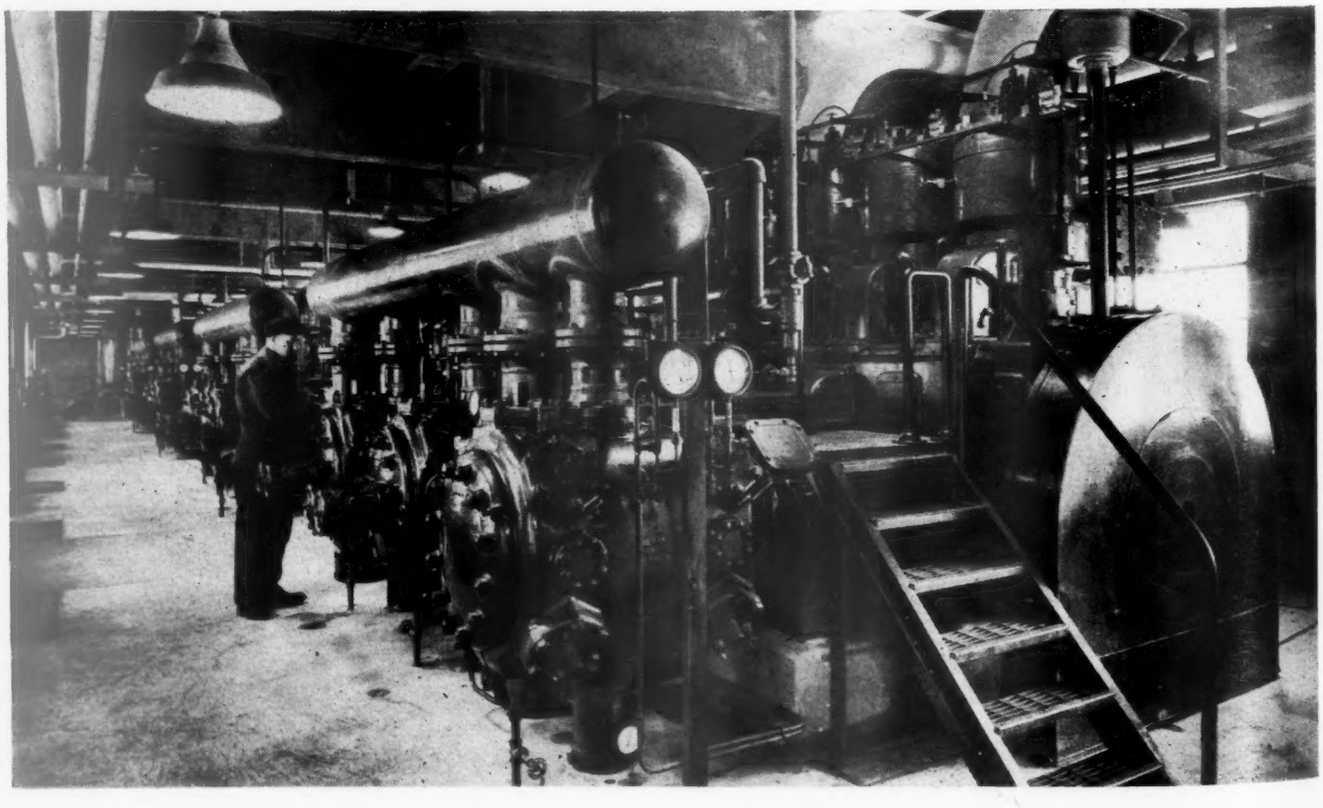
M. S. Beringer, the B-A vice president in charge of manufacturing, was entrusted with the task of rendering into lay terminology for the benefit of the company's guests the highly technical modus operandi of the new plant.

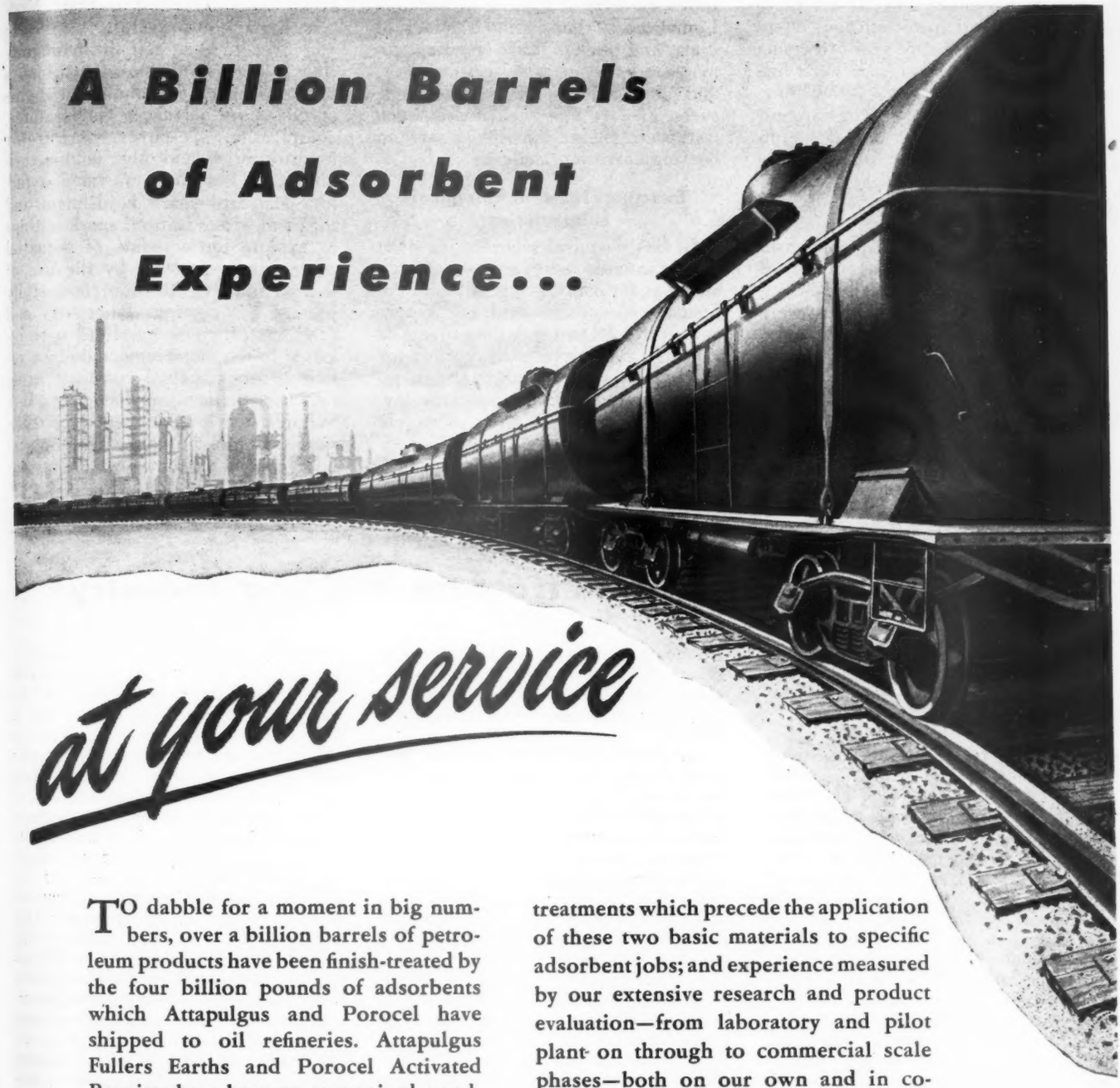
English and French-speaking guides outlined for the visitors the "high points" of the vast layout as they were conveyed over the 215-acre tract in a fleet of 8 buses. A formal reception and collation followed at the Windsor Hotel, in downtown Montreal, for guests and members of the press.

Meets '51 Car Model and Contingent Needs

British American gasolines always have been distinguished for quality, a standard that has been achieved and maintained by a continuous program of research to meet the increasingly taxing fuel requirements of modern cars. One advanced step in that development program was the installation of the Fluid catalytic cracking unit at Montreal East. With the "cat cracker" on stream, the company now has the capacity to produce gasoline with a sufficiently high octane rating

These huge compressors at British American refinery are an important part of the gas recovery system.





TO dabble for a moment in big numbers, over a billion barrels of petroleum products have been finish-treated by the four billion pounds of adsorbents which Attapulgus and Porocel have shipped to oil refineries. Attapulgus Fullers Earths and Porocel Activated Bauxites have become recognized standards in the removal or reduction of odors, colors, tastes, moisture, acids, sulfur, fluorides and unsaturates, and for solid catalyst purposes. And in this wide range of services, remarkable finished value was gained in a long list of petroleum cuts—from the lightest distillates to the heaviest lubes and waxes.

This all adds up to a lot of adsorbent experience—experience with the many treatments which precede the application of these two basic materials to specific adsorbent jobs; and experience measured by our extensive research and product evaluation—from laboratory and pilot plant on through to commercial scale phases—both on our own and in cooperation with our customers.

So there's great merit to the suggestion that it pays to consult Attapulgus and Porocel. In your own plans to improve products or expand output, perhaps our one billion barrels of adsorbent experience can be of real help to you in selecting the right adsorbent and the right conditions. Our laboratory and process staff are at your service, without obligation.

ATTAPULGUS CLAY COMPANY *Fullers Earth* • **POROCEL CORPORATION** *Activated Bauxites*

Dept. Y, 210 West Washington Square, Philadelphia 5, Pa.

to meet the demands not only of high compression engines in '51 car models, but any anticipated advance in engine design for many years to come.

When the new gasolines were formulated, the only sure way of knowing whether they came up to standard was to test them under actual operating conditions. British American has several chemical and engine laboratories for the continual testing and improvement of company products. There the qualities of the new gasolines were minutely compared with those of other brands and new manufacturing control specifications were instituted to guarantee the superior quality of B-A 88 and B-A 98 gasolines as the latest products are designated.

On a Chevrolet 6-cylinder test engine, one test involved operating the engine at constant speed, load, oil, and coolant temperatures for a total of 36 hours—equivalent to 2340 road miles, running at a speed of 65 mph. Connected to that engine a galaxy of dials and meters gave readings to measure power output, fuel economy, and engine temperatures and pressures. Factors also evaluated on such tests were engine deposits, wear and bearing corrosion tendency.

Exacting Tests in Chemical Laboratories

In B-A chemical laboratories strict new standards were set by research chemists for control of gum and gum-forming compounds and sulfur content in B-A 88 and B-A 98, capable of causing the sticking of carburetor parts, inlet valves, and intake manifold obstruction. Sulfur can cause corrosion and corrosive wear of engine parts.

Road tests under the same conditions to be experienced by future users were the final and perhaps conclusive part of the test program. Modern high compression cars were employed to road test the new gasolines. Thermionic test instruments mounted in test-cars indicated engine speed, spark advance, temperatures, compression pressures, carburetor mixture ratios, and other engine variables. The test-cars were rated at factory standard spark adjustment and then run with advanced spark settings to explore the amounts of potential power made possible by the use of B-A 88 and B-A 98. After successfully passing the rigorous laboratory and road tests, the new gasolines were released to the motoring public in a restricted area. Actual customer experience was then evaluated by B-A technical service engineers. Only then were the newest products of Montreal East released for nation-wide distribution. * * *

Instrumentation in the Petroleum Refining Industry*

What of the future trends in the use of instruments? It is my thought that the "analyzer age" in continuous process instrumentation has started.

I have been talking primarily about "environment-type" instruments—those which control temperature, pressure, liquid level and the like. It is general practice to instrument a process to hold these conditions constant at values which will permit production of a certain product at a given rate. It is customary to take periodic samples of the product stream for analysis by the control laboratory. Results of such analyses are transmitted back to the unit operators who make process condition modifications if any are required. Such control testing requires the presence of round-the-clock laboratory personnel. It also requires time—often several hours for return of test results. Economic studies have shown that "moving the laboratory to the unit" can sometimes be justified on the basis of savings in laboratory test costs, or the reduction of product loss caused by delays in obtaining sample test results at the unit. This is particularly true if it is possible to make the control tests at the unit with a continuous analyzer type instrument.

Great strides in the development of continuous analyzers were first taken during or shortly after World War II. The spectroscopic techniques of the research laboratory now are developed to the point where it is not uncommon for a petroleum refinery to have several plant-type infrared gas analyzing instruments. Ultraviolet spectrometers for plant use are available, as are instruments operating on the magnetic susceptibility, thermal conductivity and dielectric constant principles.

An infrared analyzer has been applied to the determination of the carbon monoxide content of flue gas at one of the Fluid catalytic cracking units at Baytown. An analyzer operating on the magnetic susceptibility principle is measuring the oxygen content of regenerator flue gases at both catalytic crackers, and others are in a similar service at the hydroforming unit. At the hydroforming unit these instruments guide the regeneration of beds of catalyst worth over a half million dollars, and it is hoped that they may make it possible to increase the life of the catalyst by several fold. At the catalytic crackers, the information from such analyzers helps the operators minimize after-burning with its damage to catalyst and equipment. Instruments functioning on the capacity or dielectric constant principle are being used in the measurement of the aromatic content of certain refinery streams.

It has been said many times before that if it is possible to measure accurately, it is possible to apply automatic control. It is inevitable that at least some of these continuous analyzing instruments will, in the near future, control the product quality directly.

The evolution of plant-type analyzing instruments from their research laboratory counterparts has not been completed. Most of the plant spectrometers now marketed are adaptations of laboratory designs. They are bulky, fragile, and complicated. They involve too much glassware, rubber tubing and the like. Electrically-heated, thermostatically-controlled cabinets are all too common. Analyzers are difficult to explosion-proof for hazardous areas—and the analyzer section *must* be located out in the plant because modern safe practice forbids bringing hydrocarbon samples into the control room. Future development should point to simplification.

The oil refining industry needs these new instruments designed specifically for plant use. This can be brought about by close cooperation between our engineers, research groups, instrument technicians and the manufacturers. Our refinery has two research employees assigned to the development of continuous analyzer techniques and their application to plant use. The refinery engineering division includes a group of four engineers whose primary concern is the application of all types of instruments and the design of instrumentation systems. These people maintain contacts with others in the process industries through their respective technical organizations, the Instrument Society of America and the A.P.I. It is through the efforts of these groups and of the instrument manufacturers' engineers that future development of instruments must come.

I have already said that the product quality analyzers will some day function to control nearly all continuous processes. Development in instrumentation will not cease there. It is certainly conceivable that, at some time in the future, yield information will be transmitted from the plant control room direct to the accounting machines. The analysis of pilot unit and process plant data from instruments by IBM-type machines is already being studied by research groups. It is known that one manufacturer is working on this development. *

*Condensed from a speech delivered by James Harrop, general superintendent, Baytown plants, Humble Oil and Refining Company, at the Sixth Annual Instrument Conference and Exhibit, Houston, Sept. 12, 1951.

The Wohl Equation of State Applied to Light Hydrocarbons

K. A. KOBE and H. E. von ROSENBERG

THE Wohl equation of state (equation 1) is used quite extensively in Europe to represent the behavior of gases. It is seen to be intermediate between the van der Waals equation with two empirical constants and the Beattie-Bridgeman equation with five empirical constants and hence it will give greater accuracy than the former but

$$\left[p + \frac{a}{V(V-b)} - \frac{c}{V^3}\right](V-b) = RT. \quad . \quad . \quad . \quad (1)$$

not require the mathematical calculations of the latter. It also has the advantage that the three empirical constants can be calculated from the critical constants of the gas. The constants a and b have the same physical significance as those of the van der Waals equation and c/V^3 is a correction term for the forces of repulsion among the gas molecules.

Wohl[7,8,9] made studies to show that the volumetric behavior in the gaseous state of fluorobenzene, n-pentane, isopentane, ethyl alcohol, carbon dioxide, argon, oxygen, helium, and hydrogen could be represented quite closely by his equation. He also showed[7] that the constants a and c are dependent on the temperature and rewrote his equation to introduce corrections for changing temperature. Equation 2 is the form of the Wohl equation most generally used

$$p = \frac{RT}{V-b} - \frac{a}{TV(V-b)} + \frac{c}{T^2V^3} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and is the one that will be applied in these calculations.

Equation 2 can be arranged implicitly for volume to give equation 3.

$$V^4 - (RT/p + b)V^3 + (a/Tp)V^2 - (c/T^2p)V + bc/T^2p = 0 \ldots (3)$$

At the critical point the four roots of equation 3 become equal to the critical volume and the following relationship can be derived for the values of the three constants.

$$a = 6p_c T_c V^2$$
$$b = V_c/4$$
$$c = 4p_c T_c^2 V_c^3$$

$$r_c = \frac{RT_c}{p_c V_c} = \frac{15}{4} = 3.75 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The value of the critical ratio, r_c, of 3.75 given by the Wohl equation is in good agreement with the experimental values for most normal substances (3.5 to 3.8), whereas the van der Waals equation gives a value of only 2.67.

The Wohl equation of state can also be put into a reduced form by substituting the constants from equation 4 into equation 2.

$$p_r = \frac{15\,T_r}{4\,V_r - 1} - \frac{24}{T_r V_r(4V_r - 1)} + \frac{4}{T_r^2 V_r^3} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

The reduced equation is more convenient than equation 2 for some calculations.

Dodge[1] has discussed several limiting conditions and trends that equations of state must satisfy. The Wohl equation satisfies these criteria: (1) it reduces to the ideal gas equation at low pressures and high temperatures, (2) the Boyle temperature is calculated as 2.53 T_c, which is close to the average experimental value, (3) the isometrics are substantially linear except at high densities where the curvature is negative, which is in accord with actual behavior.

Wegscheider[6] made a complete analysis of the isotherms of the Wohl equation 2 and showed that it had no theoretical basis. The region of physical significance is one in which there are positive values of temperature, pressure, and volume, and V is greater than b (Fig. 1). Below the critical temperature there are four unequal, real volume roots to the equation at the saturation pressure (curve PQRTS). At the critical point these four roots become equal and the isotherm changes to the form MNO on which the critical point is represented by a maximum rather than a point of inflection. This form is maintained until the temperature is 2.53 T_c, whereupon the isotherm takes the form FL and at higher temperatures JK.

EXCLUSIVE

The Authors

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Kenneth A. Kobe

His professional experience includes development of a process now used by Bradley-Fitch Company in recovering manganese from low-grade ores; a lachrymatory preparation, which is the war gas CNS, employed by our Chemical Corps; technical director for three years for Manganese Products, Inc., and on various other projects.

Herman E. von Rosenberg was a student and is a graduate of the Department of Chemical Engineering of the University of Texas, and is now engaged as a graduate student working toward the doctorate at the University of Delaware.

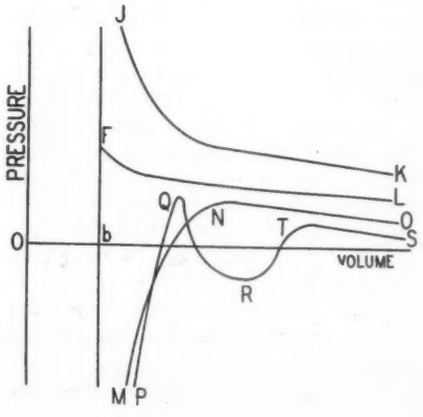
The critical isotherm turns downward at the critical point, contrary to an isotherm of the actual fluid. Hence the Wohl equation cannot represent pressure-volume relationships at volumes less than the critical volume unless the temperature is high.

Application to Real Gases

Reliable p-V-T data for the lighter hydrocarbon gases have recently been made available by Sage and Lacey[4]. In addition reliable data are available for water vapor[2] and carbon dioxide[5]. The critical constants used for these gases are given in Table 1.

The empirical constants for the Wohl equation were calculated from the critical constants using equation 4 with one modification. Because the

FIG. 1. Wohl equation isotherms.



critical volume of many gases is not known accurately, a value called the Wohl critical volume, V_c', was calculated by equation 6.

$$V_c' = \frac{RT_c}{3.75\ p_c} \quad . \quad . \quad . \quad (6)$$

The value of V_c' was used rather than V_c in calculating the values of *a*, *b*, and *c* from equation 4. The constants calculated in this manner give better results with equation 2 than do constants calculated using the true critical volume. The values of the calculated constants, the Wohl critical volume, V_c', and the experimental critical ratio, r_c, are given in Table 2.

Detailed calculations were made on methane, ethane, propane, n-butane, iso-butane, n-pentane, nitrogen, water vapor, and carbon dioxide up to a pressure of 1500 psia. The specific volume data given in the tables were substituted in equation 2 and the corresponding pressure calculated. The calculated value was compared with the actual pressure and the percentage error was calculated. These errors are given in Table 3.

Discussion of Results

A considerable variation appears to be in the percentage error, mainly because of the range of reduced temperature covered by the various compounds. The agreement of the calculated and actual pressures will be discussed for each compound.

Methane. All temperatures are above the critical temperature, so that excellent agreement is obtained. The maximum error is 1.074 per cent and the majority of errors are less than 0.5 per cent. The largest errors are for pressures greater than the critical pressure.

Ethane. The first isotherm is but slightly above the critical isotherm (100 F is $T_r = 1.018$). Errors are small until the pressure exceeds the critical value. At pressures less than the critical the maximum error is 1.667 per cent and the average error is about 0.3 per cent.

Propane and butane. Below the critical temperature the agreement is good with a maximum error of 0.90 per cent and the majority of errors under 0.5 per cent. Above the critical temperature the agreement is good for pressures up to the critical value.

Isobutane. At temperatures below the critical the agreement is not as good as with propane and butane, as the maximum error is 2.55 per cent and the average error 1.03 per cent.

n-Pentane. Below the critical temperature the agreement is similar to propane and butane, but above the critical temperature the agreement is not as good.

Nitrogen. All temperatures are

TABLE 1. Critical constants and molecular.

Gas	Ref.	Mol. wt.	Critical Temperature °C.	Critical Temperature °F.	Critical Pressure Atm.	Critical Pressure p.s.i.a.	Critical density gm/cc.	Critical volume ft³/lb. mole
Methane	4	16.042	−82.1	115.8	45.8	673.1	0.162	1.586
Ethane	4	30.069	32.3	90.1	48.2	708.3	0.203	2.373
Propane	4	44.095	96.8	206.2	42.0	617.2	0.220	3.211
n-Butane	4	58.121	152.0	305.6	37.5	551.1	0.228	4.083
Isobutane	4	58.121	134.9	274.8	36.0	529.1	0.221	4.213
n-Pentane	4	72.147	196.6	385.9	33.3	489.4	0.232	4.981
Nitrogen	4	28.016	−147.1	−232.8	33.5	492.3	0.311	1.443
Water	2	18.016	374.1	705.4	218.2	3206	0.319	0.906
Carbon Dioxide	5	44.010	31.1	88.0	73.0	1073	0.460	1.533

TABLE 2. Constants of the Wohl equation.

Gas	Critical ratio, r_c	Wohl critical volume, V_c' ft³/lb. mole	b	a	c
Methane	3.457	1.462	0.3655	2.9686×10^6	9.9505×10^8
Ethane	3.511	2.222	0.5554	1.1536×10^7	9.3955×10^9
Propane	3.606	3.088	0.7719	2.3515×10^7	3.2236×10^{10}
n-Butane	3.650	3.974	0.9936	3.9964×10^7	8.1029×10^{10}
Isobutane	3.536	3.973	0.9932	3.6806×10^7	7.1604×10^{10}
n-Pentane	3.723	4.945	1.2362	6.0718×10^7	1.6926×10^{11}
Nitrogen	3.428	1.319	0.3298	1.1660×10^6	2.3264×10^8
Water	4.304	1.040	0.2600	2.4242×10^7	1.9583×10^{10}
Carbon Dioxide	3.573	1.461	0.3652	7.5265×10^6	4.0150×10^9

TABLE 3. The error in pressures calculated by the Wohl equation.

Methane

Temp., °F. / Tr	70 / 1.540	100 / 1.627	220 / 1.975	340 / 2.324	460 / 2.673
Pressure psia	error per cent	error per cent	error per cent	error per cent	error per cent
14.7	+0.064	+0.061	+0.027	−0.007	−0.048
60	+0.150	+0.117	+0.133	+0.083	+0.050
100	+0.300	+0.300	+0.500	+0.100	+0.100
200	+0.350	+0.350	+0.250	+0.150	+0.050
400	+0.400	+0.675	+0.475	+0.300	+0.125
600	+0.867	+0.883	+0.600	+0.367	+0.133
800	+1.074	+1.050	+0.750	+0.350	+0.175
1000	+1.100	+1.000	+0.800	+0.200	+0.200
1250	+1.040	+0.959	+0.719	+0.400	0.0
1500	+0.400	+0.600	+0.667	+0.266	−0.067

Ethane

Temp., °F. / Tr	100 / 1.018	130 / 1.073	160 / 1.127	220 / 1.236	280 / 1.345	400 / 1.564
Pressure psia	error per cent	error per cent	error per cent	error per cent	error per cent	error per cent
14.7	−0.034	+0.027	+0.075	+0.007	−0.041	−0.007
50	−0.200	−0.120	0.0	+0.040	+0.060	+0.040
100	−0.300	−0.200	−0.100	0.0	+0.100	+0.100
200	−0.700	−0.450	−0.100	+0.050	+0.250	+0.150
400	−1.300	−0.850	−0.525	−0.125	+0.100	+0.100
600	−1.667	−1.167	−0.833	−0.167	+0.167	0.0
800	−3.25	−1.250	−1.374	−0.625	−0.125	0.0
1000	−27.6	−5.100	−2.70	−1.200	−0.700	−0.200
1250	−48.9	−21.3	−7.84	−2.56	−1.440	−0.640
1500	−63.2	−37.6	−18.40	−5.73	−2.67	−1.133

Propane

Temp., °F. / Tr	100 / 0.840	190 / 0.976	220 / 1.021	280 / 1.111	340 / 1.201	460 / 1.381
Pressure psia	error per cent	error per cent	error per cent	error per cent	error per cent	error per cent
14.7	−0.177	−0.054	−0.020	−0.007	+0.007	+0.020
40	−0.475	−0.150				
50			−0.100	+0.020	+0.040	+0.060
80	−0.812	−0.325				
100	−0.900	−0.400	−0.200	0.0	+0.100	+0.100
125	−0.720					
150	−0.800	−0.467				
200		−0.400	−0.450	−0.150	0.0	+0.150
300		−0.700				
400		−0.575	−0.775	−0.575	−0.250	0.0
500		−0.400				
600			−1.333	−1.333	−0.766	−0.300
800			−17.38	−2.50	−1.624	−0.775
1000			−41.6	−6.60	−3.200	−1.400
1250			−61.6	−19.61	−7.04	−2.72
1500			−75.4	−34.2	−13.68	−4.73

n-Butane

Temp., °F. / Tr	100 / 0.732	190 / 0.850	280 / 0.967	310 / 1.006	370 / 1.085	460 / 1.202
Pressure psia	error per cent	error per cent	error per cent	error per cent	error per cent	error per cent
14.7	−0.272	−0.075	−0.014	−0.007	−0.014	−0.027
30	−0.500					
50	−0.660	−0.300	−0.100	−0.060	−0.060	−0.120
100		−0.600	−0.100	−0.100	−0.100	−0.100
150		−0.733	−0.267			
200			−0.450	−0.400	−0.400	−0.350
300			−0.599			
400			−0.475	−1.000	−0.950	−0.800
600				−5.67	−1.833	−1.466
800				−42.8	−5.25	−2.50
1000				−83.7	−18.90	−5.30
1250				−82.4	−38.9	−11.29
1500				−93.5	−54.2	−19.74

TABLE 3 *(Continued)*

Isobutane

Temp., °F.		100	190	250	280	370	460
	T_r	0.762	0.884	0.966	1.007	1.129	1.252
Pressure psia		error %	error %	error %	error %	error %	error %
14.7		−0.511	−0.197	−0.075	−0.041	−0.007	+0.007
30		−0.968					
50			−0.680	−0.360	−0.180	−0.020	0.0
60		−1.167					
100			−1.300	−0.800	−0.400	0.0	0.0
150			−1.466	−1.000			
200			−1.200	−1.400	−0.950	−0.350	−0.150
300				−1.967			
400				−2.55	−1.500	−1.073	−0.575
600					−10.33	−2.00	−1.333
800					−45.8	−4.00	−2.50
1000					−65.0	−10.90	−4.80
1250					−81.2	−25.6	−9.35
1500					−92.4	−39.3	−15.8

n-Pentane

Temp., °F.		100	190	280	370	400	460
	T_r	0.662	0.769	0.876	0.982	1.017	1.088
Pressure psia		error %	error %	error %	error %	error %	error %
14.7		−0.415	−0.204	−0.14	−0.027	−0.109	−0.136
50			−0.240	−0.280	−0.220	−0.200	−0.300
100				−0.400	−0.400	−0.400	−0.600
150				−0.400	−0.667		
200					−0.850	−1.050	−1.250
300					−0.933		
400					−0.300	−1.255	−2.13
600						−15.17	
800						−49.5	−11.0
1000						−69.4	−28.5
1250						−73.5	−48.2
1500						−99.1	−62.7

Nitrogen

Temp., °F.		0	200	400	600	800
	T_r	2.028	2.910	3.790	4.669	5.550
Pressure psia		error per cent	error per cent	error per cent	error per cent	error per cent
15		+0.067	0.0	0.0	0.0	0.0
50		+0.060	−0.040	−0.060	−0.060	−0.060
100		0.0	−0.100	−0.100	−0.200	−0.200
200		+0.150	−0.150	−0.250	−0.200	−0.250
400		+0.250	−0.200	−0.375	−0.425	−0.500
600		+0.183	−0.367	−0.616	−0.684	−0.684
800		+0.237	−0.450	−0.762	−0.888	−0.875
1000		0.0	−0.700	−0.200	−1.100	−1.100
1500		−0.667	−1.267	−1.534	−1.533	−1.468
2000		−2.50	−2.10	−2.10	−2.15	−1.850

Water

Temp., °F.		212	300	400	600	700	800	1000	1400
	T_r	0.576	0.652	0.738	0.910	0.996	1.081	1.253	1.597
Pressure psia		error per cent	error per cent	error per cent	error per cent	error per cent	error per cent	error per cent	error per cent
14.7		+0.605	+0.204	+0.041	0.0	−0.020	0.0	−0.014	−0.041
50			+0.800	+0.180					
100				+0.400	0.0	0.0	−0.100	0.0	0.0
200				+1.400	−0.100	−0.150	−0.200	−0.150	−0.050
400					−0.023	−0.250	−0.300	−0.225	−0.200
800					+0.550	−0.400	−0.588	−0.474	−0.225
1000					+1.100	−0.400	−0.700	−0.600	−0.200
1500					+4.07	−0.267	−1.000	−0.867	−0.400
2000						+0.200	−1.200	−1.150	−0.550
3000						+1.533	−1.800	−1.767	−0.733
4000							−3.20	−2.50	−0.925
5000							−8.76	−3.48	−1.040

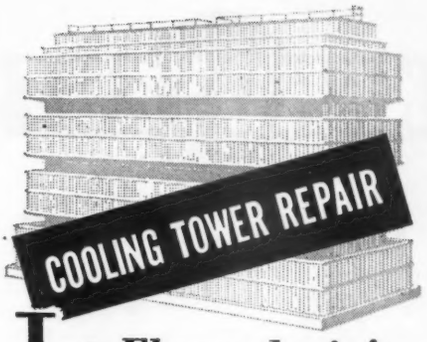
Carbon Dioxide

Temp., °F.		−75	0	50	100	200	400
	T_r	0.702	0.840	0.931	1.022	1.205	1.570
Pressure psia		error per cent	error per cent	error per cent	error per cent	error per cent	error per cent
14.0		+0.071	−0.071	0.0	+0.071	+0.071	0.0
52		+0.250	−0.173	+0.058	+0.231	+0.019	−0.019
100			−0.400	+0.100	+0.500	0.0	0.0
200			−0.400	+0.050	+0.100	+0.100	0.0
400				−0.150	−0.300	+0.125	0.0
600				−2.75	−1.615	+0.467	+0.017
800					−0.938	−0.288	+0.063
1000						0.740	−0.100
1600							−0.602
1800							−0.945

above the critical temperature. The maximum error is 2.50 per cent and below the critical pressure it is 0.5 per cent.

Water vapor. Below the critical temperature the maximum error is 4.07 per cent but the average error is 0.56 per cent. Above the critical temperature it is 8.76 per cent but for pressures below the critical the maximum error is only 1.8 per cent and most of the values are less than 0.50 per cent.

Carbon dioxide. Below the critical temperature the maximum error is 2.75 per cent and the average is 0.37 per cent. Above the critical temperature most of the compressibility data are for pressures less than the critical and the agreement is good, with a maximum error of 1.615 per cent and an average of 0.15 per cent.



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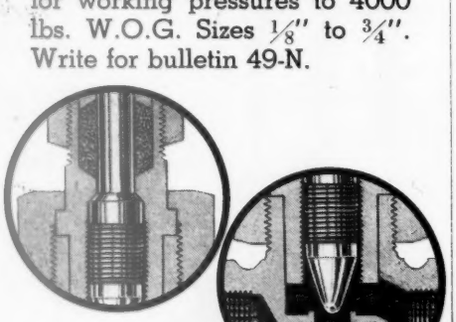

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TABLE 4. Calculated fugacities for n-Butane.

Temp. °F.	Pressure psia	Fugacity psia	Fugacity Eqn. (8) psia	Error per cent
100	50	46.0	45.0	— 2.17
190	50	47.3	46.5	— 1.69
	100	89.5	88.3	— 1.34
280	50	48.2	48.1	— 0.208
	100	93.0	92.5	— 0.537
	200	172.07	172	0
	400	288.98	290	+ 0.341
310	50	48.4	48.5	+ 0.207
	100	93.8	93.8	0
	200	175.48	174.2	— 0.740
	400	303.93	301	— 0.988
	600	376.41	380	+ 1.06
	800	401.53	368	— 8.46
	1000	425.50	352	—17.4
	1250	456.25	352	—22.8
	1500	487.93	326	—33.2
370	50	48.8	48.8	0
	100	95.2	95.1	— 0.105
	200	181.18	179.7	— 0.828
	400	326.24	323	— 0.929
	600	436.43	430	— 1.38
	800	511.41	495	— 3.13
	1000	559.25	516	— 7.69
	1250	607.80	508	—16.5
	1500	654.84	497	—24.1
460	50	49.2	49.0	— 0.406
	100	96.8	96.4	— 0.413
	200	187.20	185.9	— 0.694
	400	349.50	345	— 1.43
	600	488.20	478	— 2.05
	800	604.87	588	— 2.81
	1000	702.30	668	— 4.84
	1250	803.29	732	— 9.69
	1500	889.84	768	—13.7

Thermodynamic Calculations

The fugacity of a gas can be calculated from equation 7, which for the Wohl equation can be integrated to give equation 8.

$$\ln \frac{f}{f^\circ} = \frac{1}{RT}\int_{p^\circ}^{p} V\,dp \quad \ldots\ldots (7)$$

$$\ln f = \frac{-a}{RT^2 b}\ln\frac{V}{V-b} - \frac{a}{RT^2(V-b)} + \ln\frac{RT}{V-b} + \frac{b}{V-b} + \frac{3c}{2RT^3V^2} \quad \ldots\ldots\ldots (8)$$

The fugacity of n-butane has been calculated by equation 8 and compared in Table 4 with the values reported by Sage and Lacey[4]. The calculated fugacities show good agreement in the same regions as did the values of pressure.

Values of enthalpy, entropy, and pressure were calculated by Robinson and Bliss[3] using the van der Waals, Wohl, and Beattie-Bridgeman equations for nitrogen, methane, and propane. The calculations were made at three temperatures, two of which were near the critical point as the test is most severe there. They found for entropy calculations the Beattie-Bridgeman equation gave results within 5 to 7 per cent, and the others were within 10 to 15 per cent. For enthalpy calculations at temperatures at or below the critical, the Beattie-Bridgeman equation fits within 12 per cent, the Wohl equation within 25 per cent, and the van der Waals equation within 70 per cent. For pressure, the Wohl equation gave nearly as good agreement as the Beattie-Bridgeman equation except in the region near the critical point where it has already been seen to deviate widely.

Summary

The Wohl equation of state is an algebraic equation employing three empirical constants that can be evaluated from the critical constants of the gas. The equation was tested by calculating values of pressure up to 1500 psia for six light hydrocarbons, nitrogen, water vapor, and carbon dioxide. At temperatures below the critical, pressures up to the saturation pressure could be calculated with errors usually less than 1.0 per cent. Above the critical temperature, pressures below the critical can be calculated with errors usually less than 1.0 per cent, though a few errors up to 2.0 per cent appear. At temperatures such that the reduced temperature is 1.5 or greater, pressures up to 1500 psia can be calculated with errors usually less than 1.5 per cent. Thus the Wohl equation gives results satisfactory for most engineering purposes.

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Cost Estimating for Refineries†

A report on accuracy to be expected, the data needed, and techniques used in preparing an actual estimate

ROBERT P. WILSON*

THE detailed cost estimate of a refinery project is considered from three standpoints. Business management has as its major purpose making a profit for its investors. The ultimate purpose of a cost estimate is to provide management with the information it needs in order to spend available money in a manner that will provide the maximum return with due consideration being given to the safety of the original capital investment.

The petroleum refining industry has been revolutionized many times in the past 30 to 40 years by the introduction of new processes and new types of equipment that have made the existing processes and equipment obsolescent or in some cases completely obsolete. The continuous fractionating column, for example, replaced the batch still methods of fractionation with a resulting reduction of capital investment requirement, operating cost per unit of capacity and product improvement. Changing conditions influence the value of products to the point where it may no longer be economical to continue operation of a unit which produces a certain product. For these reasons safety of capital investment must be provided by comparatively short term payout.

Because a detailed cost estimate itself costs money, it must first be determined that the expense is warranted. This may be accomplished by reference to the cost construction of similar existing units. Cost per unit of capacity can be obtained from personal records or data compiled by others.[1] The information thus available must be corrected to date by the use of a cost index. If the proposed construction varies in size from those about which costs are available, it will also be necessary to ratio the costs up or down for cost per unit of capacity varies with size. This variation in cost per unit of capacity with size is generally not a direct ratio, but rather an exponential function. If the costs of two or more similar units are known and corrected to the same base period, this exponent may be determined.[2] Should only one set of data be available, then recourse to the "six-tenths factor"[3] is justified. A brief example may be in order at this point.

Let us assume the problem of estimating the approximate cost of an 800 bbl per day alkylation unit as of December 1950. Available data for existing units are as follows:

1. A 1700 bbl per day alkylation plant was constructed in 1946 at a total cost of $1,258,000.
2. A 3400 bbl per day alkylation plant was constructed in 1949 at a total cost of $2,209,657.

The Nelson refinery-construction index[4] for these three dates:

1946	100.0
1949	139.7
1950 December	153.4

Size of unit BPD	Total cost dollars	Total cost corrected to December 1950 dollars
1700	1,258,000.00	1,929,772.00
3400	2,209,657.00	2,426,352.07

From the relationship:

$$\left[\frac{\text{Size of the larger unit}}{\text{Size of the smaller unit}}\right]^R = \frac{\text{Corrected total cost of larger unit}}{\text{Corrected total cost of smaller unit}}$$

The exponent (R) may be calculated.

$$\left[\frac{3400}{1700}\right]^R = \frac{2,426,352.07}{1,929,772.00}$$

$$(2)^R = 1.257$$

$$R = 0.330$$

Using the same equation, the cost of the 800 bbl per day unit is calculated.

$$\left[\frac{3400}{800}\right]^{0.330} = \frac{2,426,352.07}{\text{Total cost of 800 BPD unit}}$$

Cost of 800 barrel per day unit = $1,505,181.18

An estimate, such as this, cannot be expected to be very accurate, however, some rough approximation, such as this, must be made, either mentally or on paper, to determine whether or not the proposition looks attractive enough, from the standpoint of investment return, to proceed with a more time consuming and more accurate study known as the detail cost estimate.

Assuming it has been decided to proceed with the detailed estimate, it is desirable to obtain the following information: (1) A flow diagram and plot plan of the proposed installation. (2) A materials specification list. (3) A statement or advance knowledge of the construction characteristics. (4) A survey of available utilities. These items merit some individual consideration.

Flow Diagram and Plot Plan

The first step in the construction of a refinery unit must be by development of a process flow diagram. This diagram contains information pertaining to the sequence of flow of all materials involved in the process, together with their characteristics, i. e., state—liquid, vapor, or mixed phase; quantity; viscosity; gravity; temperature; pressure, etc. It also gives the required size of towers, reflux drums, settling drums, pipe lines, heat exchangers, furnaces, and other similar data.

From this diagram the process control arrangement is developed — the instrumentation. A list of the control valves, orifice settings, control transmitters and receivers, pressure gages, temperature indicators, and recorders of all types may be prepared and the flow diagram revised to show this instrumentation schematically.

With this information, the mechanical design department can supply data concerning vessel thicknesses and weights, foundation and structural designs, pump specifications, driver qualifications, utility requirements, and the plot plan or location and arrangement of this unit with respect to others and of the items of equipment contained in the unit under consideration with respect to each other.

Material Specification List

This information is generally supplied by the mechanical design department and consists of standards for insulation material, pipe, valves, gaskets, flanges, steel, concrete, and methods of construction.

Construction Characteristics

In a refinery, as in few other places, a considerable emphasis must be placed on this item. Equipment in operation at the time of other construction frequently must continue to function, placing limitations on welding, movement of equip-

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1Cost-imating series, W. L. Nelson, The Oil and Gas Journal, Tulsa, Oklahoma. Issues of November 24, December 1 and 8, 1949.

2How to Estimate Plant Construction Costs, G. E. Brooks, The Petroleum Engineer, Refining and Gas Processing Edition, Dallas, Texas, Vol. 22, No. 3, 4, and 6, 1950.

3Six-Tenths Factor, "Aids in Approximating Costs," Roger Williams, Jr., Chemical Engineer, Vol. 54, No. 12, 1947, 124-125.

4Appearing in the first issue each month, W. L. Nelson, The Oil and Gas Journal, Tulsa, Oklahoma.

ment, connection of piping, excavations, and similar work.

The availability of materials and equipment is rather important, for delay of construction due to lack of material is often expensive.

Utilities Survey

The estimator must know what utilities are available in the vicinity, for if designed consumption exceeds availability, then additional water, gas, steam, electricity, air, etc., must be provided as a part of the construction cost for if they are not, the unit cannot function and the investment cannot be retired.

Armed with this additional information, the estimator can attack the problem intelligently. It is general practice to attain the total estimated cost by estimating the individual components as accurately as possible and to add to the sum of these costs a contingency figure that will be discussed later.

Components of the Estimate

Main Equipment. Pumps and drivers, accumulator drums, towers and trays, heat exchangers — the main process equipment — are generally purchased prefabricated. Therefore, their costs are most accurately determined by the submission of requirements or sketches to various manufacturers or fabricators for bids. If prices are quoted F.O.B., freight and unloading charges should be added to the bid price. Should time not be available for this procedure, reference to actual costs of similar equipment can be brought up to size and date in a manner similar to that used for approximating the cost of the entire unit.

If the shells of the towers and drums are to be fabricated by plant facilities, the cost of material is determined on a weight basis — so much per pound. Labor costs are also a function of total weight with additions to labor costs made for the number and size of connections for piping and platforms.

Foundations and Structures. Concrete foundations are generally estimated on a cost per cubic yard basis. The cost to include excavation, forming, fabrication, and installation of reinforcing, pouring, finishing, removal of forms, and clean-up. The cost per cubic yard increases with the complexity of the job from the simplest non-reinforced slab floor to complex, reinforced octagonal footings for self-supporting towers. A more accurate method is to estimate the cost of the individual operations outlined above and to arrive at the total cost by summation of the component costs.

Erected costs of steel structures are estimated on a per pound basis — so much for material, shop fabrication, field erection, and welding. Grating and floor plate costs are generally on a per square foot basis.

Erection of Equipment. Erection costs for towers and drums may be estimated as a percentage of material costs but such a procedure may yield results of questionable accuracy. A knowledge of available power equipment and other facilities together with first or second hand information regarding the number of man-hours required for the job will produce a cost figure of greater probable accuracy.

The erection of overhead piping and the insulation of structures or equipment will require the use of scaffolding. If sectional tubing or similar types of scaffolding are available, only the cost of putting it together and movement to location need be considered, but if lumber types must be used, cost of material or material loss must be included.

Pipe, Valves, and Fittings. Reference to the flow diagram, plot plan, and material specifications is made to determine the number and type of valves and the amount and size of pipe required. Generally the major portion of this item is the cost of valves. Particular attention must be paid to specifications for the cost of a 4 in. valve may be anywhere from $50 to $1000. The cost is dependent upon the type, size, trim, material, and series of service rating for temperature and pressure. Once these features are tied down and the number required of each size determined, these costs may be obtained from published catalogues and current discounts applied, or prices may be obtained directly from the local distribu-

FIG. 1. TYPICAL COST ESTIMATE.

ENGINEERING DEPARTMENT

For Install 140 psig Absorber at Cracking Unit — Date 24 August 19 50

Estimate No. 4177

Request No.

Drawing No. — Sketch No.

Pieces	MATERIAL	Dollars	Cents
	Instruments	2,300	00
	Tower foundation & sewer relocation	629	10
	Condenser support	650	00
	Concrete trench for 10" gasoline line	2,679	45
1	5'-6" x 10'-0" Gasoline reflux accumulator	1,269	29
30	Trays and seal pan for absorber tower	1,477	22
1	7'-10" x 40'-0" Gasoline surge drum	4,501	00
2	Griscom-Russell #29-6-168 O.H. condensers	13,152	79
3	Relief valves	415	84
18	2nd. hand G-Fins and connectors	1,125	00
1	3HR2 Worthington pump, G.E. Turbine & seal	1,422	76
	Electrical material for lights & instruments	3,000	00
	Pump foundations	69	00
	Pipe, valves and fittings	18,000	00
2	Platforms for drums	355	40
1	3'-0" x 62'-9" Absorber tower	5,538	40
	Scaffolding lumber	300	00
	Paint	250	00

LABOR							
						$57,135	25
MACHINISTS		170	00				
PIPE FITTERS		7,500	00				
BOILER MAKERS AND BLACKSMITHS)		2,700	00				
WELDERS)							
CARPENTERS		1,720	00				
BRICK MASONS							
ELECTRICIANS		1,500	00				
PAINTERS		600	00				
LEAD BURNERS							
INSTRUMENT LABOR	X					500	00
BULL GANG		600	00				
COMMON LABOR		900	00				
CONCRETE LABOR		750	00				
TRUCK, TRACTOR, CRANE	X					700	00
ASBESTOS WORKERS							
TINNERS							
ENGINEERING	X					2,300	00
		$16,440	00				
OVERHEAD		4,932	00				
						$21,372	00
						$82,007	25
CONTINGENCIES						4,792	75
TOTAL						$86,800	00

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tor. Sufficient accuracy may be obtained by determining the cost of major valves, (2 in. and larger) and adding a single sum to cover smaller valves, keeping in mind that there may be hundreds of ½ in., ¾ in., 1 in., and 1½ in. valves, required for bleeders, orifice settings, manifolds, pressure gage connections, and the like.

Pipe required and the sizes of piping can be estimated from the flow diagrams and plot plan. Process, instrument, start-up, and utility systems must be covered. The cost for each size and weight is obtained on a per foot basis.

The number, size, and type of fittings and flanges must be determined and the costs obtained from catalogs or manufacturers representatives.

Labor for the fabrication of piping and the installation may be estimated as a percentage of pipe and small valve costs plus an amount per major valve and fitting of each size. The percentage for labor costs is not taken on the entire material cost, for as was pointed out, valve costs are widely variant and essentially it takes the same labor to install each size valve regardless of its cost. The cost of pipe labor may exceed the cost of piping material on a job where small size lines and/or complex manifolds are a large part of the job.

Insulation. The material specification lists are again consulted to obtain information about the types and thicknesses of insulation for vessels and piping. Labor and material costs are then estimated on a per square foot basis for vessels and large size lines. For lines 12 in. and smaller, a lineal foot basis for each size and thickness may be used.

Buildings. Building costs are generally based on the type of construction to be used and the number of floors. The cost determined as an amount per square foot multiplied by the floor area and by a factor for the number of floors. In general, the total cost for the same floor space is less as the number of floors increases and as the external dimensions approach a square.

Electrical Work. Much of the electrical equipment used in refineries is vapor-proof or explosion-proof. The cost of such types of equipment may exceed normal types of several hundred per cent. Therefore, specifications must be carefully surveyed. Individual items — motors, lights, starting equipment, conduit, etc., may be priced from distributors or catalogs. Labor is best estimated on a man-hour basis in view of the variation in equipment costs.

Painting. Painting is generally done to protect equipment and facilities. Specifications should be consulted again to ascertain the number and types of coats to be applied. Material requirements and labor units are then determined on the basis of the surface to be covered and the number of coats required. Manhours of labor and coverage per gallon vary with the method of application. Structures and vessels exposed to the weather may be sprayed while interiors of buildings probably require brush application, involving a greater labor factor.

Engineering and Drafting. The cost of preparing the construction drawings and material lists and the survey work for the job may be estimated as a percentage of the total cost—generally in the neighborhood of 5 per cent. As usual a more accurate figure is obtained by estimating the manhours of labor involved and multiplying by the average hourly wage.

Miscellaneous. The estimate must include all items necessary for the operation of the unit. This includes such things as office furnishings, laboratory facilities, charges of foreign material (catalyst, acid, solvent, etc.) to the unit, fully paid-up or part-paid royalties, and waste disposal facilities, if required, to mention only a few.

On a large estimate, it would be needlessly expensive to price each and every item involved. The intention is to provide an estimate of reasonable accuracy at a reasonable expense, not to attain the greatest possible accuracy. Therefore, minor items that would not materially affect the result are usually "lumped" as miscellaneous. Management will usually regard 5 per cent to 10 per cent as sufficiently accurate. With experience, care, and adequate information 2 per cent to 3 per cent accuracy can be attained.

Overhead. In addition to direct labor charges to the job, a percentage of the total plant labor charge to the job is added to cover such items as holiday pay, sick time, workmen's compensation insurance, social security payments, group insurance plans, etc. This overhead cost will naturally vary from plant to plant and should be obtained from the Accounting Department. In lieu of any information, a reasonable figure would be 15 per cent.

Contingencies. Over and above all estimated costs should be added a contingency item to cover such unpredictable factors as inflation, strike delays, destruction of equipment or material, underestimation of costs due to omissions, etc. As a rule, the amount of this item may be taken as a percentage of the total estimated cost less the cost of items to be purchased on fixed price contracts. The accuracy with which the estimate has been made, the stability of the current wage, price and labor situations, govern the percentage to use—normally 10 per cent may be satisfactory.

Presentation of the Completed Estimate. The final step of the detail cost estimate is to assemble the calculations for summation. One example of a form for such a summation appears in Fig. 1. It is advisable, at this point, to recheck the work for obvious omissions. For example, if an item of material appears as paint, then an item for painters' labor should appear. Very generally speaking, the total labor cost will be equal to the total material cost (prefabricated items of material excluded). If a wide variation is noted, then the situation should be verified or corrected.

Delays in Approval. Should the final estimate be disapproved and at some later date, due to market changes, be reconsidered, then the estimate itself should be reviewed in the light of new costs. Quite possibly construction indexes may be used to bring the entire cost up to date. In any event, most of the work will have been done and it should be a relatively simple matter to prepare a new estimate for submission. In times such as these of rapid inflation, this is important because the same factors that operate to make the payout appear more attractive may, at the same time, push construction costs to bring the payout right back where it began.

Experience, the best teacher, is of no value unless the results of the cost estimate can be compared with the actual cost of the completed job. This information should be available to the estimator if he is expected to do a good or better job in the future. To know the final total cost is of some value, but only examination of detailed final costs will reveal where the errors have been made and allow correction in succeeding estimates.

To summarize what has been said: First, find out what is to be done—obtain flow diagrams, plot plans, utility surveys, and the specifications of materials to be employed. Second, break the job down into comprehensible items. Third, estimate the costs of individual items and summarize these costs. Fourth, prepare a revised estimate, if consideration is long delayed. Finally, to improve technique, compare final job costs with originally estimated costs. ★ ★ ★

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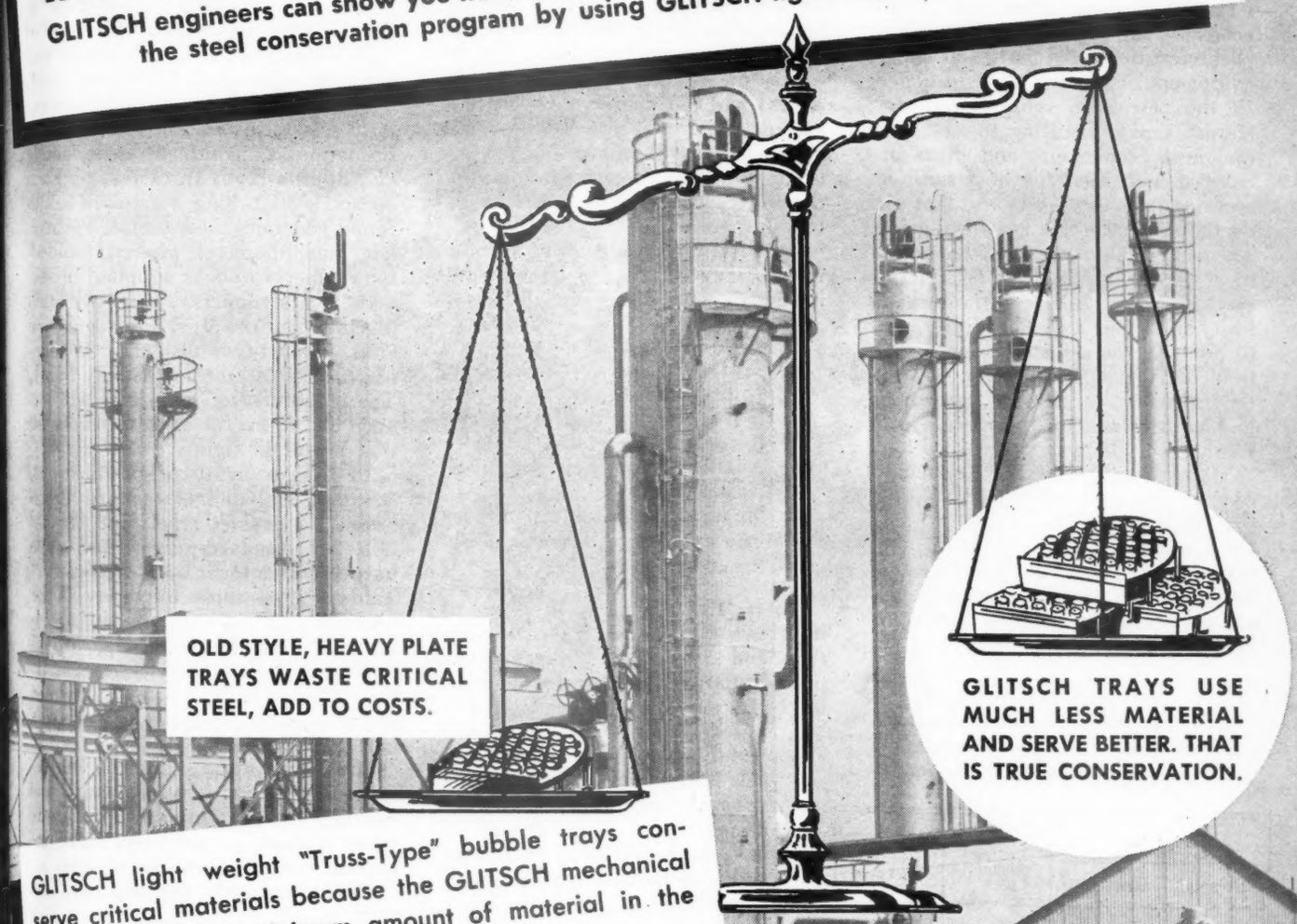

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- GLITSCH patented "Truss-Type" construction can conserve critical materials in addition to offering the many other advantages of; flexibility of design, simplified installation, ease of cleaning, saving of costly downtime, minimum of maintenance, small replacement inventories, and indefinite tray life.

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Insulation and Application Methods for Heated Piping

SPECIFICATION of insulating materials and application methods is governed by the physical and operating characteristics of the particular heated equipment or surface to be insulated. In the petroleum refining industry, storage tanks, distilling towers, boilers, heat exchangers, and ducts are covered with the type of insulation, securing members, and finish that will do the most effective heat-saving job. The most common type of plant equipment requiring insulation is piping—carrying water, steam, gas, oil, chemicals, and other materials from point to point in the refinery. Pipe insulation contributes in large proportion to the efficiency of refinery operations and is, therefore, of direct concern to engineers in the field.

There are many recommended procedures for applying pipe insulation that have produced excellent results for many years with only occasional maintenance. There are four particular conditions the alert plant engineer and experienced insulation contractor first consider in specifying insulation on a given pipe line. These are (1) temperature of the pipe contents, (2) outside diameter of the pipe, (3) location of the pipe (indoors or outdoors) and (4) degree of exposure to external damage. These conditions are most common; among others are orientation of piping (horizontal, vertical, or diagonal), exposure to moisture and vibration.

Specifications based on such information may be divided into the following categories:

1. Type of primary pipe insulation —molded-type or blanket-type.
2. Dimensions of primary insulation — length, thickness, sectional or segmental.
3. Auxiliary and finishing materials.
4. Methods of installing primary insulation, auxiliary and finishing materials.

There are two common types of mineral wool pipe insulation, *blanket-type* and *molded-type*. Blanket-type pipe insulation is mineral wool reinforced on one or both sides by a suitable confining material and bound to form a nonrigid insulating section. Blanket-type mineral wool pipe insulation is designed and manufactured to have both maximum flexibility and high thermal efficiency and is produced in sizes to fit piping from 2-in. diameter and up. The most common confining materials used are either metal lath or wire netting, both of which are secured by wire or cord ties through the mineral wool itself. Blanket-type pipe insulation is commercially manufactured in 24-in.-long single-layer sections, 1-in. to 4-in. thick, for standard pipe sizes. Standard blankets are selected having dimensions that will assure a snug fit to the pipe at specified insulation thicknesses.

Molded-type mineral wool pipe insulation consists of mineral wool combined with bonding ingredients to form a rigid insulation. This type of pipe insulation combines rigidity and strength with good insulating characteristics and is shaped to be particularly easy to install. Molded-type pipe insulation is manufactured in single and double-layer thicknesses. Each section is 36-in. long, a standard length found generally most useful. To insulate small-diameter piping, molded-type mineral wool is supplied in sections (half-cylinders), which are fitted together over the pipe. For larger pipe sizes, molded-type insulation is manufactured in segments (usually four). The manufacturer maintains a tolerance of 1/6-in. for all dimensions so that it will fit tightly.

In order to facilitate specifications, standard and double-standard thicknesses of molded-type pipe insulation for standard-weight steel pipe have been set forth by the industry.* Table 1 gives these thicknesses* for nominal pipe sizes from ½-in. to 14-in. and up. Molded-type pipe insulation may also be manufactured in 1, 1½, 2, 2½, 3, and 4-in. thicknesses for all nominal pipe sizes given in the table.

"On large piping, usually 14-in. in diameter and up, it is often very satisfactory to apply mineral wool insulating cement, particularly where irregular surfaces are encountered in combination with the piping. The

*Commercial Standard CS-117-49, "Mineral Wool Insulation for Heated Industrial Equipment."

TABLE 1. Molded-type insulation—thicknesses[a] for standard-weight steel pipe sizes.

Pipe size		Standard thickness	Double standard thickness
Nominal	Actual O. D.		
in.	*in.*	*in.*	*in.*
½	0.840	⅞	1¾
¾	1.050	⅞	1¾
1	1.315	⅞	1¾
1¼	1.660	⅞	1¾
1½	1.900	⅞	1¾
2	2.375	1½₃₂	2⅛₆
2½	2.875	1½₃₂	2⅛₆
3	3.500	1½₃₂	2⅛₆
3½	4.000	1½₃₂	2⅛₆
4	4.500	1⅛	2¼
4½[b]	5.000	1⅛	2¼
5	5.563	1⅛	2¼
6	6.625	1⅛	2¼
7[b]	7.625	1¼	2½
8	8.625	1¼	2½
9[b]	9.625	1¼	2½
10	10.750	1¼	2½
11[b]	11.750	1¼	2½
12	12.750	1½	3
14 and up	----------	1½	3

[a]In addition to the thicknesses specified above, molded-type pipe insulation may be manufactured in thicknesses of 1, 1½, 2, 2½, 3, and 4 in. for all nominal pipe sizes.
[b]These pipe sizes are not listed as standard for steel pipe in Simplified Practice Recommendation R57-32, Wrought-iron and Wrought-steel Pipe, Valves, and Fittings.

TABLE 2. Recommended minimum insulation thicknesses—mineral wool pipe insulation.

Blanket-type				Molded-type			
Temperature	Thickness			Temperature	Thickness		
	Pipes 2 in. to 4 in.	Pipes 4 in. to 6 in.	Pipes 6 in. and up		Pipes below 2 in.	Pipes 2 in. to 4 in.	Pipes 4 in. and up
°F	*in.*	*in.*	*in.*	°F			
150 to 250	1	1	1	Up to 275	Std	Std	Std.
250 to 350	1	1	1	275 to 350	do	do	1½".
350 to 450	1	1	1½	350 to 425	do	1½"	2".
450 to 550	1	1½	1½	425 to 500	1½"	2"	Dbl. std.
550 to 650	1½	1½	2	500 to 600	2"	Dbl. std.	Do.
650 to 750	1½	2	2				
750 to 900	2	2	2½				
900 to 1,050	2	2½	3				
1,050 to 1,200	2½	3½	4				

insulation thickness required by pipe temperature is built up on the pipe in separate layers; it is recommended that each layer be no thicker than ¾-in. Each layer should be allowed to dry thoroughly before application of further insulating cement."

More heat will be saved on any pipe line if the thickness of the insulation is increased; however, the cost of insulation per foot of piping also increases. There is, therefore, an economic thickness of insulation which will result in maximum heat savings per dollar of cost. Table 2 gives recommended minimum insulation thickness for blanket-type pipe insulation, 150 F to 1200 F, and molded-type pipe insulation, from below 275 F to 600 F. For each type of pipe insulation, the recommended minimum thicknesses are given for three ranges of pipe diameter. Note that the data for molded-type pipe insulation refers to the standard and double-standard insulation thicknesses given in Table 1. The thicknesses tabulated in Table 2 are recommended for indoor applications. When piping is placed outdoors, as is common in the petroleum industry, it is recommended that the insulation thickness be increased not less than ½-in. Because earth is of some insulating value, thickness may be decreased ½-in. when piping is installed underground.

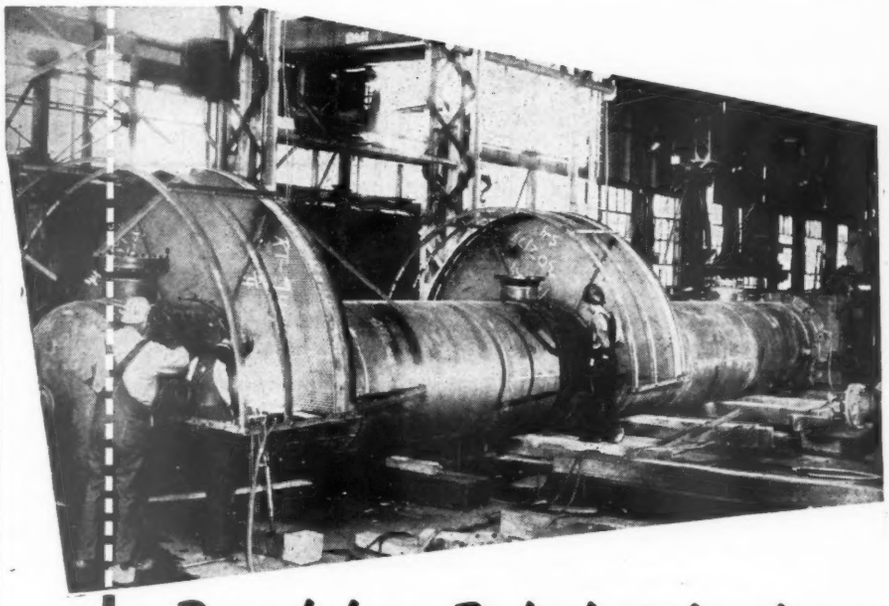
Application of Blanket-type Insulation

Usually applied on straight piping and long-radius bends of 2-in. standard pipe size or larger, blanket-type pipe insulation (Fig. 1) is first wrapped circumferentially around the bare pipe. The longitudinal edges are then secured by tying or lacing with 16-gage galvanized soft iron wire, preferably on the under side of the piping. The mineral wool blanket sections are tightly butted together on the pipe to provide an unbroken insulation covering.

The materials and method in which blanket-type insulation is finished depends upon whether it is located indoors or outdoors. There are four generally accepted materials for finishing insulation on indoor piping, (1) mineral wool insulating cement, (2) roofing-felt, (3) asphaltic mastic or emulsion and (4) canvas. Insulating cement is applied over the blanket-type pipe insulation in two ¼-in. layers. The first layer is trowelled on and allowed to dry before the second is applied. As the second alternative finish, asphalt-saturated roofing-felt is wrapped around the piping, lapped at least 2-in. and often sealed with an asphaltic compound or lap cement. Roofing-felt should be securely held over the pipe with copper wire or galvanized iron bands spaced on approximately 6-in. centers along the pipe.

To apply an asphaltic finish to indoor piping covered with blanket-type pipe insulation, a ¼-in. layer of mineral wool insulating cement is first applied and, when dry, is covered with 1-in. galvanized-wire netting stretched over the surface and tightly wired in place. Asphaltic mastic or emulsion is then trowelled into the wire netting to provide a ⅛-in. dry thickness (or about ¼-in. when wet). As a base for a canvas pipe jacket, a layer of flameproof paper, $\frac{1}{16}$-in.-thick asbestos paper or a ¼-in. layer of insulating cement is first applied. The canvas jacket is then sewn or pasted over the base material. To insure a tight cover on a sewn canvas jacket, the stitches should be spaced at no more than 1/3-in. intervals along the pipe.

When blanket-type pipe insulation covers piping located either outdoors or exposed to moisture or accidental damage, it is usually finished and weatherproofed by sheet- metal jackets, roofing-felt or an asphalt compound. A sheet-metal jacket should be at least 28-gage, single or double-galvanized. The seams are lapped down-



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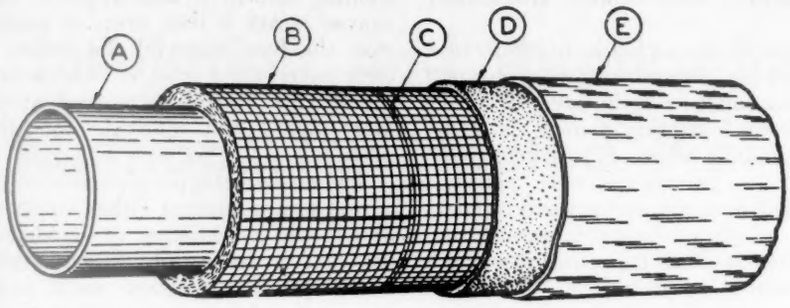
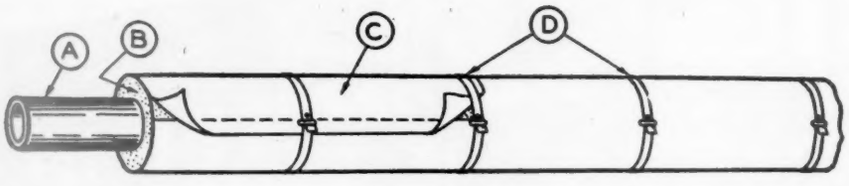


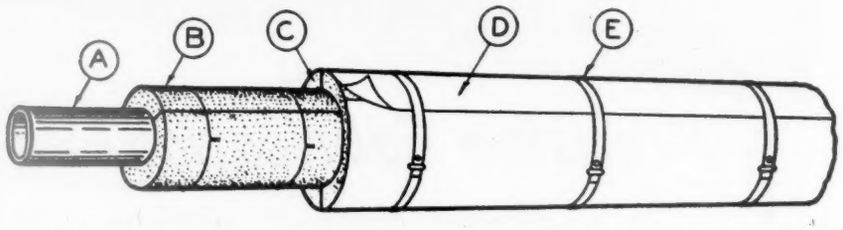
A. Bare pipe
B. Blanket-type mineral wool wrapped circumferentially around bare pipe
C. Joints secured with No. 16-gage galvanized wires
D. Insulating cement
E. Asphaltic or other specified finish.

FIG. 1. Application of blanket-type mineral wool pipe insulation on pipes.



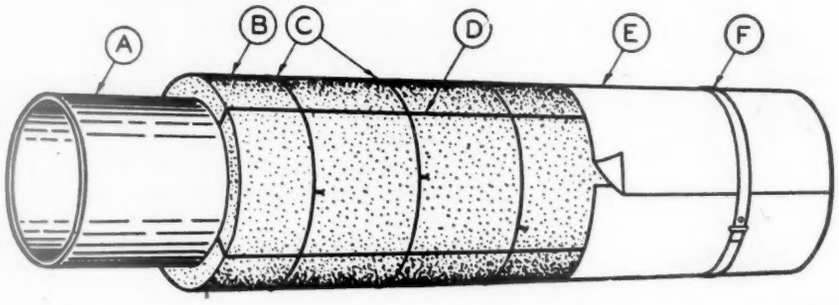
A. Bare pipe
B. Sectional mineral wool pipe insulation
C. Canvas jacket or other specified finish
D. Metal bands.

FIG. 2. Application of mineral wool sectional pipe insulation, single-layer.



A. Bare pipe
B. First layer secured with No. 16-gage galvanized wires
C. Second layer applied with all joints staggered
D. Canvas jacket or other specified finish
E. Metal bands.

FIG. 3. Application of mineral wool sectional pipe insulation, double-layer.



A. Bare pipe
B. Segmental pipe insulation
C. No. 16-gage galvanized wires
D. Insulating cement, when required
E. Canvas jacket or other specified finish
F. Metal bands.

FIG. 4. Application of mineral wool segmental pipe insulation.

ward against the weather and secured with galvanized metal bands, ½-in.-wide or greater, which are machine-stretched and crimped. It is not recommended that the bands be spaced at much more than 6-in. centers along the pipe.

The roofing-felt finish is applied in the same manner outdoors as described above for indoor locations. To avoid the possibility of wetting the insulation, it is very important to lap the roofing-felt downward. An asphaltic finish is applied in the same manner outdoors as in indoors, making certain that the asphaltic coat is sufficiently thick and even at all points.

Application of Molded-type Insulation

The single and double-layer methods of applying sectional molded-type pipe insulation are illustrated in Fig. 2 and 3. In Fig. 2, single-layer sectional insulation is placed over the piping, with all sections tightly butted together, and is covered with a canvas jacket and banded in place. Double-layer application of sectional pipe insulation in Fig. 3 requires that the first layer be wired in place with loops of wires placed on approximately 8-in. centers. The second layer is tightly fitted directly over the first layer with all joints staggered to avoid aligning edges. As with single-layer application, a canvas jacket (or other finish) and metal bands follow.

Application of segmental molded-type pipe insulation in Fig. 4 is similar to the procedure followed with sectional insulation. Although Fig. 4 shows a single-layer method, double-layer segmental pipe insulation can also be obtained. On such large-diameter piping, mineral wool insulating cement is often trowelled over the installed segments before applying the canvas jacket or other finish.

A canvas jacket is the most satisfactory finish for molded-type pipe insulation located indoors and not exposed to moisture or abrasion. The canvas jacket is drawn tightly over the pipe and smoothly pasted at all lapping edges. The metal bands should be secured over the canvas at both the center and ends of each length of insulation. When factory-weight canvas is specified, insulation and canvas are supplied as a unit.

Molded-type pipe insulation installed on outdoor piping or in locations where accidental damage or wetting might occur is finished in one of the three ways recommended for blanket-type pipe insulation under similar conditions. All finishing methods are excellent; the specifier and insulation contractor select the finish most appropriate for particular conditions. * * *

Catalytic Cracking

Factors Affecting Throughput†

Plant Design, Operating Conditions, and Catalyst Properties Are Main Factors Influencing Unit Yields and Economics

P. M. REYNOLDS*

Catalyic cracking has been developed in the refining industry to increase the gasoline yield from crude, raise the octane of gasoline, and decrease the amount of fuel oil product. Thermal cracking was the first step refiners took to increase gasoline yield and octane number. But thermal cracking produces about 35 per cent No. 6 fuel oil; whereas, catalytic cracking produces 5-8 per cent coke and about 45 per cent light gas oils. The coke is utilized within the cracking unit itself and about 30 per cent of the gas oil product may be sold as No. 2 burner fuel and the remaining gas oil further cracked thermally. This leaves an ultimate No. 6 burner fuel production of only about 10 per cent on cat cracking charge.

To properly evaluate the capacity of a given unit the following considerations must be studied:

1. Unit Design and Operation
2. Feed Stock
3. Economics of Product Distribution.

Unit Design and Operation

During the last decade, three designs of catalytic cracking units were commercialized. These basic types are:

1. **Fixed-Bed.** This unit is composed of three or more catalyst containing vessels or "cases" manifolded together with piping such that one or more beds may be on cracking stream while the remainder are being regenerated. The oil, steam, and air are switched from catalyst case to catalyst case by automatic synchronized timing devices. In the typical three-case unit, one case is on stream 10 minutes, valving and purging 10 minutes, and burning 10 minutes. These three operations are staggered and thus one case is on stream all the time, a switch being made every 10 minutes. The catalyst beds remain fixed and the temperature of the bed is maintained at a comparatively constant temperature level by circulating a molten salt through finned heat transfer tubes extending through the catalyst mass. The catalyst is usually in the form of pills or pellets about 1/6 in. in diameter and length.

2. **Thermofor.** This design employs separate vessels for reaction and regeneration. The catalyst is moved continuously from the reactor to the regenerator and back by elevators. The regenerator bed temperature is controlled by steam coils in the burning zone. The catalyst used in these units must have flow characteristics similar to granular percolation clays so as to be easily moved and transported during operation. These catalysts masses consist largely from 4 to 60 mesh size.

3. **Fluid.** The Fluid process has separate reactor and regenerator units through which the catalyst continuously circulates going alternately through reaction and regeneration. The catalyst is moved from the regenerator to reactor by means of vaporized oil feed and steam. Catalyst is moved back to the regenerator by air and flue gases. It is blown by the gases and acts like a fluid. It consists of a finely divided powder varying from 500 microns to 10 microns in size.

Development of other types of units is under way, but these three designs contain fundamental details of catalytic cracking. Regardless of how the oil and catalyst are contacted or how the catalyst is transported, the cracking reaction is essentially the same. The basic differences in the theoretical design and operation of the various types of units lie in the heat balance of reaction and regeneration. From the refiners' standpoint, all designs perform the same operation; i. e., manufacture a high octane gasoline from various mixtures of gas oils. The general considerations that follow pertain directly only to the Fluid type unit, but nearly the same relationships apply to all designs.

a. *Catalysts.* As previously stated, the Fluid catalyst is a finely divided powder consisting of masses of microscopic crystals. Each grain of powder is composed of a number of crystals. It is made from natural clays or syn-

†Presented at the second annual John Zink Process Heating Seminar at the John Zink Company, Tulsa, Oklahoma, May 26, 1951.
*Mid-Continent Petroleum Corp.

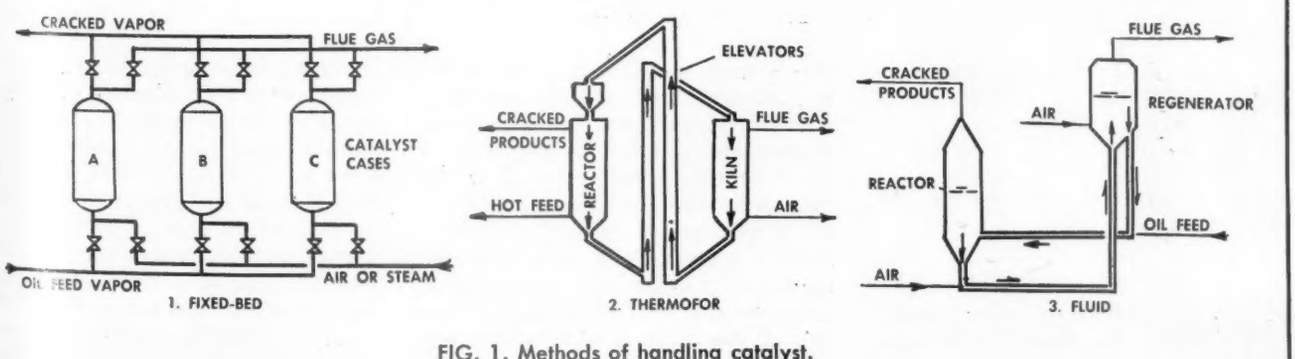


FIG. 1. Methods of handling catalyst.

Heat balance of reaction and regeneration of a Fluid catalytic cracking unit at two coke laydown rates

Case 1 Coke laydown = 6.0 per cent fresh feed
Case 2 Coke laydown = 5.5 per cent fresh feed

Fresh feed and conversion at same rate as Case 1

Material Balance
(Applies to Case 1 and Case 2)

Fresh feed, 30 API gas oil	= 20,000 BPD = 255,000#/hr
Total recycle, 27 API	= 25 vol. per cent fresh feed = 5,000 BPD = 65,050#/hr
Conversion	= 55 vol. per cent disappearance of fresh feed
Total gas oil product, 29 API	= 45 vol. per cent fresh feed = 9,000#/hr BPD = 115,600#/hr
Dispersion steam to reactor	= 10,000#/hr = 140 PSIA, 100 F S.H.

Regenerator flue gas analysis[6]

Dry basis	Mol. per cent
CO_2	12.0
CO	6.0
O_2	1.0
N_2	81.0
	100.0

Heat of cracking reaction	= 95 Btu per lb of gasoline plus gas at 900 F
Heat of combustion of coke	= 14,500 Btu per lb gross H. V. at 32 F
Average specific heat of catalyst from 900 — 1075 F	= 0.270 Btu per lb
Reactor at 900 F, 15 psig Regenerator at 1075 F, 9 psig Coke laydown	= 6.0 wt. per cent of fresh feed = 15,300#/hr
Hydrogen in coke	= 9.0 wt. per cent of coke = 1,377#/hr
Carbon in coke	= 91.0 wt. per cent of coke = 13,923#/hr
Gasoline plus gas products	= 255,000—115,600—15,300 = 124,100#/hr
Air to regenerator	= 190,010#/hr
Water of combustion of coke	= 1,377 x 9 = 12,400#/hr
Total flue gas from regenerator	= 190,010+15,300 = 205,310#/hr

Heat Balance of Generator (Basis 32 F)

1. Heat Into Regenerator	Btu per hour
Combustion air in at 300 F = 190,000 (300-32)(0.241)	= 12,270,000
Sensible heat of coke at 900 F = 15,300 (900-32)(0.60)	= 7,971,000
Heat of combustion of coke = 15,300 x 14,500	= 221,850,000
Total heat into regenerator excluding catalyst circulation	= 242,091,000

2. Heat Out Of Regenerator	Btu per hour
Sensible heat in flue gases = 205,310 (1075-32)(0.269)	= 57,603,000
Latent heat of water in flue gases = 12,400 x 1075	= 13,333,000
Heat loss out of regenerator insulation	= 1,000,000
Total heat out of regenerator excluding catalyst circulation	= 71,936,000
3. Heat available to circulating catalyst = (242,091,000-71,936,000)	= 170,155,000

Heat Balance of Reactor

1. Heat Required in Reactor	Btu per hour
Heat and vaporize feed in at 100 F = 255,000[135 + (900-100) (0.710)]	= 153,765,000
Heat and vaporize recycle in at 400 F = 65,050[119 + (900-400) (0.656)]	= 29,077,000
Heat of reaction = 124,100 x 95	= 11,790,000
Heat dispersion steam = 10,000 (1611-1250)	= 3,610,000
Heat loss through reactor insulation	= 600,000
Total reactor duty required	= 198,842,000

	BTU per hour
2. Heat From Circulating Catalyst	= 170,155,000
Thus, heat put in feed by furnace = (198,842,000-170,155,000)	= 28,687,000

3. Feed Heater Outlet Temperature

$$\text{Temp. diff.} = \frac{28{,}687{,}000}{255{,}000 \times 0.535} = 210 \text{ F}$$

Thus, furnace outlet temp. = 100 + 210 = 310 F

Catalyst circulation

$$= \frac{170{,}155{,}000}{(1075\text{-}900)\ (0.270)} = 3{,}601{,}000 \text{ \#/hr}$$

$= 30.0$ tons/min

Cat/Oil Ratio

$$= \frac{3{,}601{,}000}{255{,}000} = 14.1 \text{ to 1 on fresh feed}$$

$$= \frac{3{,}601{,}000}{(255{,}000 + 65{,}050)} = 11.3 \text{ to 1 throughout}$$

Case 2

Coke laydown	= 5.5 wt. per cent of fresh feed = 14,025#/hr
Hydrogen in coke	= 9.0 wt. per cent of coke = 1,262#/hr
Carbon in coke	= 91.0 wt. per cent of coke = 12,763#/hr
Gasoline plus gas products	= 255,000 - 115,600 - 14,025 = 125,375#/hr
Air to regenerator	= 174,150#/hr
Water of combustion of coke	= 1,262 x 9 = 11,360#/hr
Total flue gas from regenerator	= 174,150 + 14,025 = 188,175#/hr

Heat Balance of Regenerator (Basis 32 F)

1. Heat Into Regenerator	Btu per hour
Combustion air in at 300 F = 174,150 (300-32)(0.241)	= 11,250,000
Sensible heat of coke at 900 F = 14,025 (900-32)(0.60)	= 7,307,000
Heat of combustion of coke = 14,025 x 14,500	= 203,363,000
Total heat into regenerator excluding catalyst circulation	= 221,920,000

2. Heat Out Of Regenerator	Btu per hour
Sensible heat in flue gases = 188,175 (1075-32)(0.269)	= 52,877,000
Latent of water in flue gases = 11,360 x 1075	= 12,212,000
Heat loss out of regenerator insulation	= 1,000,000
Total heat out of regenerator excluding catalyst circulation	= 66,089,000
3. Heat Available to Circulating Catalyst = (221,920,000-66,089)	= 155,831,000

Heat Balance of Reactor

1. Heat Required in Reactor	Btu per hour
Heat and vaporize feed in at 100 F = 255,000 [135 + (900-100) (0.710)]	= 153,765,000
Heat and vaporize recycle in at 400 F = 65,050 [119 + (900-400) (0.656)]	= 29,077,000
Heat of reaction = 125,375 x 95	= 11,911,000
Heat dispersion steam = 10,000 (1611-1250)	= 3,610,000
Heat loss through reactor insulation	600,000
Total reactor duty required	= 198,963,000

2. Heat From Circulating Catalyst	= 155,831,000
Thus, heat put in feed by furnace	= 43,132,000

3. Feed Heater Outlet Temperature (Assume No Vaporization)

$$\text{Temp. diff.} = \frac{43{,}132{,}000}{255{,}000 \times 0.587} = 282 \text{ F}$$

Thus, furnace outlet temp. = 100 + 282 = 382 F

Catalyst Circulation

$$= \frac{155{,}831{,}000}{(1075\text{-}900)(0.270)} = 3{,}294{,}000 \text{ \#/hr or}$$

$= 27.5$ tons/min

Cat/Oil Ratio

$$= \frac{2{,}906{,}000}{255{,}000} = 12.9 \text{ to 1 on fresh feed}$$

$$= \frac{2{,}906{,}000}{255{,}000 + 65{,}050} = 10.3 \text{ to 1 on throughput}$$

Fresh Feed Possible in Case 2 if Coke Burning Rate Maintained at 15,300 lb per hr as in Case 1

$$\text{Case 2 new fresh feed} = 20{,}000 \text{ BPD} \times \frac{15{,}300 \text{ \#/hr}}{14{,}025 \text{ \#/hr}} \text{ or}$$

$$= 20{,}000 \text{ BPD} \times \frac{6.0\%}{5.5\%}$$

$= 21{,}820$ BPD

Compound	*Per Cent*
Si_2O_3	73.8
Al_2O_3	17.0
Fe_2O_3	2.3
TiO_2	0.4
CaO	2.2
MgO	4.3
	100.0

thesized chemically. The approximate composition of the natural grade is as follows:

The synthetic catalyst most commonly used contains more silica and less alumina, iron, and calcium than natural. But the largest difference in natural and synthetic catalyst is in the type of crystals existing in the catalyst masses. In general synthetic, the higher priced catalyst, produces higher octane, less coke, less debutanized gasoline of a higher vapor pressure, and more olefins and isobutane. If the olefins and isobutane are converted into alkylate and polymer, the overall debutanized gasoline for synthetic catalyst would be about the same as for natural catalyst. In some cases for the same depth of cracking, natural catalyst will handle as much feed as synthetic catalyst due to the fact that natural catalyst requires less excess oxygen during regeneration to burn coke from catalyst properly. This depends somewhat on catalyst poisoning by dirty feedstocks. Where the catalyst poisoning rate is not great, however, synthetic catalyst will not only produce less coke, but will also

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This unit has a *combination packing and bearing* made of Teflon. The material is tough, chemically resistant; stands up to 400° F. and has a low coefficient of friction. Teflon flows slightly under pressure to adjust itself to the stuffing box body and the periphery of the shaft. It seals without binding! The spring loaded follower serves as a pilot to hold the Teflon in alignment. All other parts are stainless steel. Packaged stuffing box kits for converting meters in service are available.

ROCKWELL MANUFACTURING COMPANY
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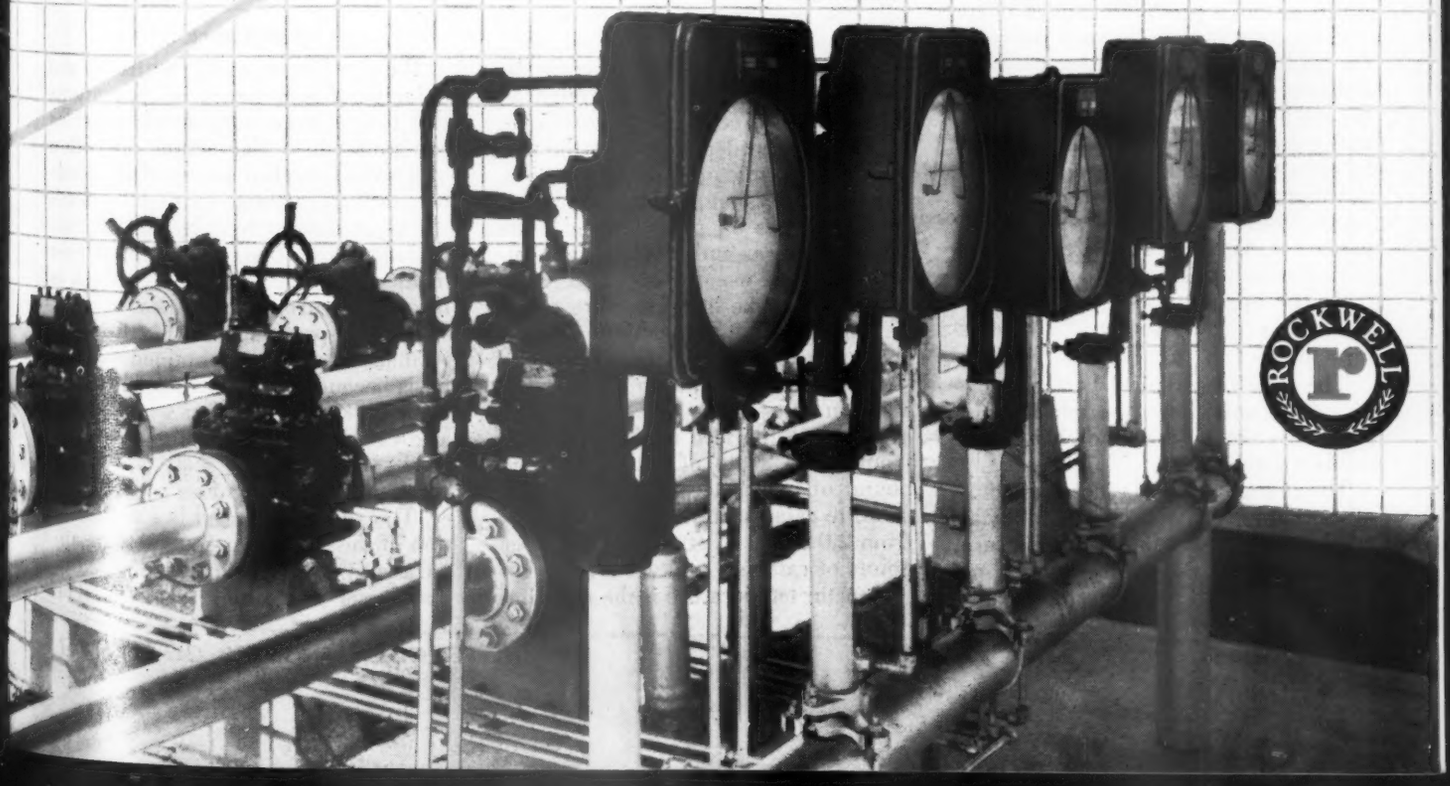


allow the same coke burn off for a given aid capacity.

Three functions of the catalyst are:

1. Reaction catalyzer
2. Heat transfer medium from regenerator to reactor
3. Medium for handling coke

The cracking promotion quality of "activity" of a catalyst determines conversion level. Activity is high when the catalyst is new, but after several hundred hours of operation it levels off to its own activity level according to feedstock, operating conditions, and type of catalyst. Economic operating levels of activity are much lower than originally predicted in the design of the earlier units.

b. *Heat Balance.* The gas oil feed to the reactor must be heated to a vapor at reaction temperature and heat of reaction must be supplied. In fluid operation this feed heating is accomplished, in some instances, first by exchange with products from the fractionator, then heating in a furnace and finally by mixing with the hot regenerated catalyst from the regenerator. The catalyst circulation is automatically controlled by large "slide valves," which open and close to regulate the final reaction bed temperature. The regenerator must burn all the coke formed on the catalyst in the reactor; thus, the heat of combustion must be removed from the regenerator. Majority of the heat of combustion is removed from the regenerator by catalyst going back to the reactor and the remaining heat must go out with the flue gases or be removed by circulating catalyst through coolers or waste heat boilers. The heat balance of the regenerator is a function of the amount of coke burned. Some units are designed so as not to require recycle catalyst coolers. In this "heat balanced" type of unit the heater on the gas oil feed must vary up and down as coke production goes down and up, respectively, to keep the reactor and regenerator in temperature balance. If the regenerator and reactor are held at a constant temperature, and coke production goes up suddenly, then the oil heater must be slowed down and catalyst circulation stepped up to remove more heat from the regenerator. Otherwise the regenerator temperature will go up and out of control. The opposite case is also true when coke production in the reactor goes down.

The following typical heat balance of a fluid unit shows the relationship between coke laydown, preheat, and catalyst circulation.

The change in coke laydown as actually occurs in the operation of any cat cracker may be attributed in this case to a change in nature, or source, of feed. Fresh feed, recycle rate, and reactor temperature were held the same in both cases so as to best show the relationship between the variables. In actual operation feed and reactor temperature would be varied so as to maintain maximum coke burning in the regenerator since the coke burning capacity is usually the limiting factor in a unit. In Case 1, the feed furnace outlet temperature was down to 310 F due to the large amount of heat liberated in the regenerator by the combustion of coke. In Case 2, the coke was down to 5.5 per cent of the feed, and thus more heat had to be put into the oil in the furnace to maintain the 900 F reactor temperature as there was less heat of combustion of coke in the regenerator. This change in coke laydown rate is a typical occurrence on commercial units and the operators vary the furnace outlet temperature to take care of such changes. The catalyst circulation rate changes automatically to take care of the heat balance of the regenerator.

The crystalline nature of natural catalyst allows water or steam to be adsorbed into its structure. Part of the steam in the reactor and stripper is adsorbed by the catalyst, and in the regenerator the adsorbed steam is stripped off the catalyst by high temperature and low partial pressure of steam. Due to this hydration, natural catalyst requires more stripping steam than synthetic catalyst. The heat released by the adsorption, which amounts to about 1500 Btu per pound, reduces catalyst circulation requirements because of heat liberation picked up by the catalyst coincident to the adsorption that supplied heat for the reaction in the reactor.

c. *Reaction with Catalyst.* Operating variables by which the operator maintains the desired product distribution between debutanized gasoline, iso and unsaturated butanes, and cycle oils are reactor temperature, recycle ratio, space velocity, cat to oil ratio, and catalyst activity. It is generally desirable to obtain a conversion or "per cent cracked" from 40 to 75 per cent fresh feed depending on the prevailing economic product distribution. Higher conversion produces more gasoline, less gas oil product, and more undesirable gas and coke. The conversion limit is usually obtained when the gas and coke increase more rapidly than gasoline production. The reactor is usually held between 900 and 975 F. Fluid units attain catalyst circulation rates so as to have a cat to oil ratio on the feed to the reactor of from 10 to 20 lb of catalyst to one pound of oil. Space velocity or ratio of oil to catalyst in the reactor ranges from 2.0 to 1.0 lb of oil per hour per pound of catalyst.

Reactor temperature is the most important of these variables. A small change in reactor temperature is sensed throughout the unit by changes in conversion, coke, and gas. The relation between these primary variables to depth of cracking, coke and gas production also depends on the nature of feedstock. Operating correlation of these factors often is difficult on a commercial unit due to the large number of changes constantly taking place.

d. *Regeneration of Catalyst.* Coke-laden catalyst is returned continuously to the regenerator where the coke is removed from the catalyst by controlled burning. The regeneration temperature is usually held between 1050 and 1100 F, but must be limited to 1125 F to prevent metal failure of the regenerator vessel itself and to prevent damage to the catalyst. Catalyst circulating back to the reactor removes the largest portion of the heat of combustion of the coke and the remainder of the heat goes out with the flue gases in the general case. Fluid units designed to handle a high per cent carbon to feed have catalyst coolers through which catalyst is circulated to and from the regenerator and subsequently cooled.

Regeneration capacity is usually one of the limiting factors in the throughput of a catalytic cracking unit. The superficial average flue gas velocity in the regenerator should be kept below 2.2 ft per second to prevent excess catalyst carry over loss in the exit flue gases. When all of the combustion air required to give this limiting velocity of 2.2 ft per second in the regenerator is used, then the coke burning capacity of the unit is reached and coke formation in the reactor must not be allowed to go any higher. Blower capacity for combustion air need not be any higher than enough to reach this maximum allowable regenerator velocity.

Feedstock

Pilot or bench scale results do not coincide with commercial operations due to the large number of variables encountered in the actual operation of a unit. Therefore each refiner needs to relatively evaluate each of his feedstocks available. Some recent investigations show that one of the best methods for evaluating a feed stock is the use of aromaticity measured by specific dispersion, but very little information has been obtained on this basis because the test is difficult to run —the dark color interfers with the test. Mid-Continent has evaluated feedstocks on a bench scale apparatus using modifications of an activity tester. The equipment used is a modification of the Atlantic activity testing apparatus. Oil is heated and charged to the vessel containing catalyst. The

products are condensed and fractioned. The catalyst is removed from the reactor and coke test run on it. All tests are run with the same amount of oil and catalyst, and at the same temperature. Fig. 2 is a plot of distillation curves of various cat cracker feedstocks with the carbon production on the activity tester written on each curve. All tests were run under the same conditions, thus only relative carbon forming tendencies are obtained. Correlation is not shown relating the carbon formation between the three general types shown. But within any group, the carbon primarily is a function of the boiling range of the stock—the higher boiling materials form more carbon. This type of test eliminates most of the operating variables of commercial units. Some of these data, however, do not correspond accurately with actual plant operation. This is the first step in prediction of coke, gas, and gasoline yields of a particular feedstock.

Feed preparation other than topping and reducing crude for gas oils now being used by several companies are viscosity breaking, delayed coking, and propane decarbonizing. These methods are used primarily to reduce coke and gas yield tendencies and catalyst poisoning from residual nitrogen, sulfur, and metals. Residual stocks are not usually fed directly to a catalytic cracking unit without some clean up. Some refiners are proceeding with feed cleanup by solvent extraction of aromatics and naphthenes from stocks recycled within the cracking unit itself. The result of this type operation concerning conversion to gasoline, coke, gas is not yet certain.

Economics of Product Distribution

Other than gasoline and light gases, cracked gas oils or "catalytic cycle oils" are the remaining product yields from the catalytic cracking operation. The light gases are routed into the refinery fuel gas system and the isobutane and olefin hydrocarbons may be alkylated or polymerized into high octane gasoline. The lightest fractions of the cycle oil may be blended into burner and stoves distillates and the heavy cycle oils may be cracked to gasoline by thermal cracking.

To balance available feed against possible products is the major problem of the refiner. It is usually advisable to feed all clean cracking stocks through a catalytic unit maintaining maximum coke burning at all times. This sometimes means that low conversion must be maintained and large volumes of cat cycle oils produced to be further handled on a thermal unit. Highest yields are obtained in this manner by catalytic cracking first. Higher octanes and less No. 6 fuel oil are produced. The price of burner fuels and gasoline has an important bearing on the split up of the cycle oils into burner fuel and thermal cracking charge. Fig. 3 shows the distribution of cycle product between "Per Cent No. 2 Burner in Cycle Oil" and "Total Product Value" without considering operating costs for 15,500 bbl per day cat cracking charge capacity. In all cases shown, as much No. 2 burner oil as possible should be split out of the

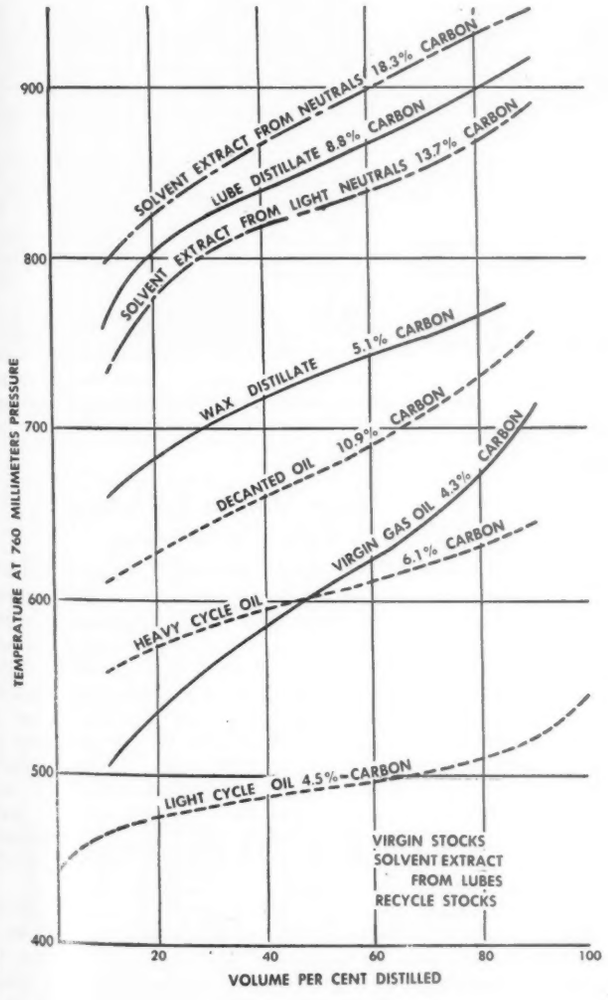
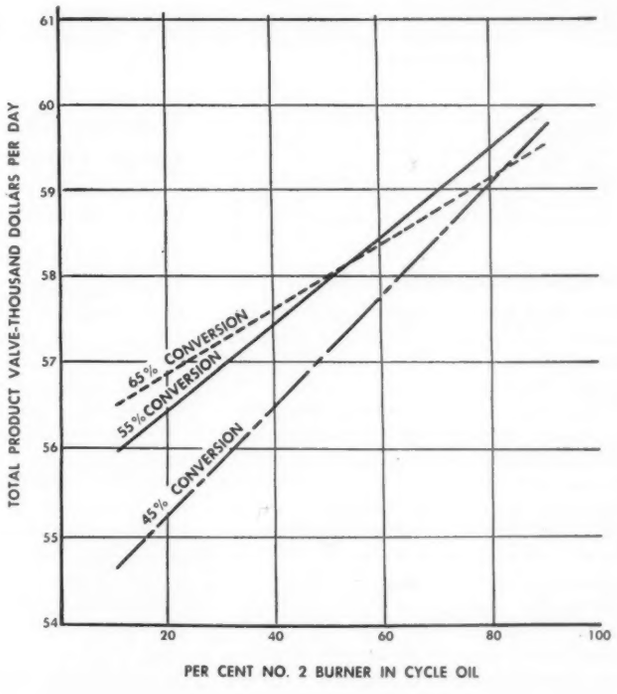


FIG. 2. Cat cracking feed stock carbon-boiling range relationship.

FIG. 3. Cat cracking product value.



cycle oil as the value of the burner fuel is higher than the value of thermal cracking charge. In fractionating the No. 2 burner, the limit is usually determined by the pour point of this cut. In most cases the No. 2 burner yield doesn't get above 50 per cent of the cycle oil fraction, but under favorable feedstocks and operating conditions that is sometimes possible. This graph also shows that it would be best to operate at 65 per cent conversion if up to 50 per cent of cycle oil could be sold in No. 2 burner fuel.

If a large No. 2 burner yield were possible, however, then conversion should be dropped to about 55 per cent and a larger fraction of cycle oil be sold as No. 2 burner fuel. The slope and position of these lines change as the prices change for each product. Operating on the right-hand side of this graph is one of the rare cases where maximum coke laydown rate should not be maintained on a cat cracker. This would open the way for more at cracking feed if the price of No. 2 burner stayed up and if it were possible to make a large yield of No. 2 burner for long periods of time enough to warrant operation on the right side of the graph.

Conclusion

The addition of catalytic cracking to modern processing has offered more flexibility in petroleum refining. In doing so it has opened the way for each refiner to make the most profit possible by varying his products to meet the highest market demands. This may be done by considering the equipment on hand, by visualizing the charge stocks available, and by evaluating properly the optimum product distribution.

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* * *

Chemical Exposition Set

The 23rd Exposition of Chemical Industries will be held in Grand Central Palace, New York City, November 26 through December 1.

With every exhibitor showing from one to a dozen or more new products, the itemized catalog of introductory displays will run into thousands. Many chemical substances have been developed as a direct result of the program for national defense, bringing with them byproducts as offshoots from the necessary research, swelling the number of new products. New materials and processes for speeding up production of materials already in use have sparked the improvement of processing equipment to a greater extent than ever before.

NEWS

Sunray Booster Stations Are Now in Operation

The installation of radio microwave communication facilities along Sunray Oil Corporation's refinery utilities line between its plants at Allen and Sunray (Duncan), Oklahoma will be completed by early fall.

Two new booster stations on the 6-in. pipe line connecting the company's two refineries are already in temporary operation and the complete installation will give Sunray the most modern facilities available.

The addition of the Rock Island plant at Duncan to the Sunray catalytic cracking schedule was also a factor in planning increased facilities. Having been remodeled and redesigned, the former Rock Island plant, now leased by Sunray, has been put "on stream" and is supplying stock for the adjacent big catalytic cracking unit.

With conventional pump stations already operating at Duncan, Wynnewood, and Allen, the two new Sunray booster stations will be 25 miles east and west of Wynnewood. Through installation of horizon to horizon microwave radio control facilities, installed by RCA, a Sunray operator at the central Wynnewood station will be able to start or stop either or both pump stations along the line by push-button method. The Wynnewood station will also receive by microwave radio a continuous chart record of the operation at each booster station on a 24 hour per day basis.

The complete installation of the new modern control system should mean a maximum throughput of more than 650,000 bbl (27,300,000 gal) of product blending components per month when operating at maximum capacity. This increases the capacity of the utilities lines by approximately 15,000 bbl per month.

Davison Chemical to Build Large Catalyst Plant

The Davison Chemical Corporation will erect one of the largest catalyst plants in the United States on the Calcasieu River, six miles south of Lake Charles, Louisiana, it was announced by R. L. Hockley, vice president of Davison. The site will provide for production of other chemicals in addition to catalysts.

Cost of the plant is estimated at about $7,000,000. Scheduled for operation early in 1953, it will have facilities for producing synthetic fluid petroleum cracking catalyst sufficient to process nearly 600,000 bbl of petroleum stocks per day, based on average refinery use of cracking catalysts.

The Lake Charles plant, Hockley disclosed, will produce the microspheroidal type of synthetic silica-alumina catalyst. This form of catalyst is closer to being spherical, and more uniform in particle size distribution, than some former types, and is preferred by many in the industry.

Sun Plans Refinery Expansion

Sun Oil Company is engaged in a two-year construction and modernization refinery program that will cost in the neighborhood of $40,000,000, its president, Robert G. Dunlop, revealed.

Additionally, Sun Oil has contracted with Sun Shipbuilding and Dry Dock Company for two super-tankers of 30,000 deadweight tons each. These will be constructed during the next 15 months at a cost for the two of approximately $15,000,000.

These items are the highlights of Sun's current expansion, modernization and rehabilitation program. The refinery program will increase the company's total refining capacity between 35,000 and 40,000 bbl a day, increase its output of military aviation gasoline and permit large volume production of benzene and other materials in critically short supply.

The largest single item in the two-year refinery program is approximately $10,000,000 for construction of a 10,000 to 15,000 bbl-a-day refinery at Sarnia, Ontario, Canada. This construction will include a Houdriflow catalytic cracker. This project, however, will not really get under way until next spring.

Stanolind Will Get New Stripping Plant

Stanolind Oil and Gas Company of Tulsa, Oklahoma has awarded a contract to Blaw-Knox Company for the engineering and supply of a gasoline stripping unit to be erected at the Gilliam gasoline plant near Shreveport, Louisiana.

To be a standard Blaw-Knox package type model, the unit will be designed to process 1,500,000 cu ft of gas per day at a pressure of 350 lb and a temperature of 100 F. It will be equipped with a water cooling system and a safety shut-down.

Stripper plants remove liquid vapors from the natural gas, thereby protecting the gas lines against pressure drop and recovering the valuable liquid fractions such as natural gasoline, butane, propane, etc.

Large Unit to Be Added To Phillip's Terminal

Phillips Chemical Company will add another large unit to its Adams terminal facilities near Houston, Texas, for the production of chemical components used by synthetic fiber manufacturers. Principal products of the new plant will be special high purity pyridines, one of which will be sold to manufacturers of a new synthetic fiber. Other products will include picolines, lutidines, and mixed pyridines, which will be marketed to manufacturers of pharmaceuticals, resins, dyestuffs, rubber chemicals, insecticides, and solvents.

Construction of this new chemical plant will begin as soon as necessary Government approvals are issued. It will be erected adjacent to the company's ammonium sulfate plant and completion is scheduled for June, 1952.

Ashland another leading refiner who desalts with PETRECO

The Ashland Oil and Refining Company and its affiliated companies are a fast growing and highly progressive organization. Like other leaders in the refining field, Ashland relies on Petreco Desalters to keep their crude charge free from harmful salts and solids. Like the many other experienced refiners who specify Petreco Desalting repeatedly, the Ashland group has installed Petreco in their refineries at Ashland, Kentucky; Canton, Ohio and Buffalo, New York.

Leading refiners such as the Ashland Oil and Refining Company have learned that Petreco Desalters consistently deliver high-efficiency performance, and are kept at this high performance level by helpful, dependable Petreco service engineers. **PETRECO OFFERS COMPLETE DESALTING SERVICE AND FACILITIES**

GET THE BEST IN DESALTING

Minimum residual salts and solids

Reduced furnace plugging, longer tube life

Maximum exchanger efficiency

Less corrosion in the topping section

Salvaged waste oil

Clear water bleed

Trouble-free, automatic operation

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PR 51-6

San Francisco Site of 1952 API Refining Meeting

The 17th midyear meeting of the Division of Refining, American Petroleum Institute, will be held in San Francisco, May 12, 13, 14 and 15, 1952, W. L. Stewart, Jr., Institute vice president for refining announced recently.

This will be the first midyear meeting of the Division of Refining to be held on the Pacific Coast. Besides a full schedule of committee meetings, an elaborate technical program is being planned by the Program Committee under the chairmanship of W. M. Holaday, director of Socony-Vacuum Laboratories, New York. Technical sessions are tentatively planned on a number of basic refinery subjects. Offers on the following subjects are welcomed by these committees:

1. Corrosion and Corrosion Prevention
   E. Q. Camp, Humble Oil and Refining Company, Box 3538, Baytown, Texas.
2. Electrical Equipment
   L. M. Goldsmith, The Atlantic Refining Company, 260 South Broad Street, Philadelphia, Pennsylvania.
3. Analytical Research
   E. L. Baldeschwieler, Standard Oil Development Company, P. O. Box 51, Linden, New Jersey.
4. Waste Disposal
   L. Mittelman, Tide Water Associated Oil Company, 79 New Montgomery Street, San Francisco.
5. Training Personnel
   T. M. Rushing, The Texas Company, 135 East 42nd Street, New York 17.
6. Automotive Fuels and Lubricants
   T. B. Rendel, Shell Oil Company, 50 West 50th Street, New York 20.
7. New Refining Processes
   W. T. Gunn, American Petroleum Institute, 50 West 50th Street, New York 20.

Lion to Build Another Ammonia Plant

Lion Oil Co. will build another anhydrous ammonia plant costing $30 million, announcement states. The company is considering the Charlotte, North Carolina, area for a possible site, though no decision has been reached. Gas supply shortage, however, may cause abandonment of any such plan, the Piedmont Natural Gas Co. not having enough gas to supply the new plant. Lion has applied to the Securities and Exchange Commission for authority to issue additional 350,000 shares of common stock, and to Defense Production Authority for Certificate of Necessity to accelerate amortization of costs.

Magnolia Contemplates Plant Construction

Tentative plans for the construction of a jointly owned gasoline plant to take care of the gas produced with the oil in the Spraberry trend area were made last week by several of the operators. It is contemplated that Magnolia Petroleum Company will construct and operate a gasoline plant to handle casinghead gas produced with the oil from Spraberry production in the general area where Midland, Upton, Reagan and Glasscock Counties join.

Among the operators interested in the project are Magnolia, Sinclair, Atlantic, Sunray, Stanolind, Tidewater Associated, Sohio, Sun and others.

General Aniline Pushes Expansion

General Aniline and Film Corporation announced that it had recently completed arrangements to secure $20,000,000 from a major insurance company, with which to carry forward the company's post-war expansion program. The first phase, totaling neary $30,000,000, is nearing completion it was said.

General Aniline products include dyestuffs, intermediates, detergents, acetylene chemicals, cameras, photographic film, paper and sundries, as well as Ozalid facsimile reproduction machines and materials. It was stated that all sections of the Company's operations are included in the expansion plans.

As a necessary step in carrying out the projected plans, the company announced the creation of two new executive posts.

Dr. Cary R. Wagner has been elected senior vice president and John C. Franklin has been elected vice president of operations of General Aniline Works, the company's dyestuffs and chemical division.

Fawley, England, Refinery Opened

The $105,000,000 refinery of Esso Petroleum Co., Ltd., at Fawley, England, was opened officially by Prime Minister Atlee Sept. 14, advisers say. This plant, a subsidiary of Standard of New Jersey, is the largest in Europe and will produce some 42,000,000 bbl of products annually. These products include a million gallons of motor fuel (spirit) daily, or 30 per cent of the United Kingdom's total motor fuel demand. This plant comes on stream at a crucial time, when the largest refinery in the world is shut down at Abadan, owned and operated formerly by Anglo-Iranian Oil Co. England has been guaranteed enough motor fuel for its requirements for the remainder of 1951 by this plant and other British and American oil companies, to make up the deficit caused by Abadan's shutdown, Atlee announced. The new refinery is located on Southampton harbor.

To Build 55-Ton Sulfur Unit

Standard Oil Company (Indiana) announced today that construction has been started at its Whiting, Indiana, refinery on a plant for the production of 55 tons per day of elemental sulfur.

The Fluor Corporation, Ltd. of Los Angeles, California, has been awarded a contract for construction of the new plant which will extract hydrogen sulfide from by-product fuel gases produced in the refinery and convert it into elemental sulfur of 99.9 per cent purity. It is expected that the plant will be completed and ready for operation about the middle of 1952, provided no delays are encountered in obtaining the necessary construction materials.

Detergent Plant for Israel

Determined to develop its petro-chemical industry, and to utilize the refining capacity existing in the country, the Israel Government has projected the establishment of a $2,500,000 polymerization and alkylation plant for the production of detergents. Details of the project are published in the August issue of "Economic Horizons," monthly publication of the Economic Department of the Jewish Agency for Palestine.

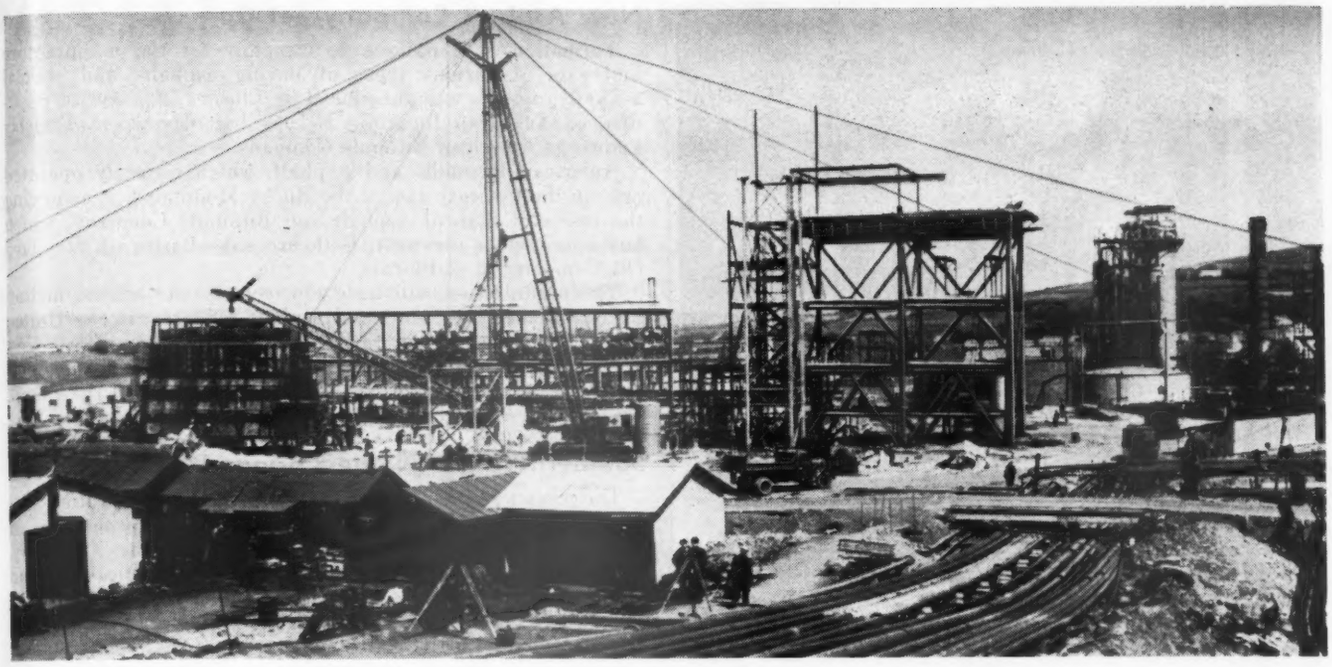
Raw material for the proposed plant would be supplied by the Haifa Refinery in the form of liquid propane (propylene gas).

The plant would be designed for an annual output of 3000 to 3500 tons of detergents, two-thirds of which would be required to meet domestic needs and the rest to be available for export. The 2000 odd tons used domestically would be sufficient to reduce Israel's normal soap consumption by half. This would improve the foreign exchange balance of the country by about $1,000,000 per year.

New Petrochemical Firm Projected

Alamo Chemical Company is the name of a new manufacturing organization projected by Phillips Chemical Co., General Aniline and Film Corp., and the Borden Co., large operators in dairy and plastic products, according to information received recently. Stated by participants to be in the conversation stage, the new company will involve expenditures of more than $38 million for a plant on the Houston Ship Channel in Texas. Nearby is the Phillips Chemical Co.'s ammonium sulfate fertilizer plant where atmospheric nitrogen and hydrogen from hydrocarbon gases are converted into ammonia. The new plant will synthesize ammonia for the same purpose, methanol (methyl or wood alcohol) and acetylene, the last of which may be used as an intermediate in a very large number of syntheses.

General Aniline and Film Corp., of which Jack Frye is president and Dr. C. R. Wagner is recently elected senior vice president, is a large operator in the organic chemical, photochemicals and dyestuffs fields, as well as in the manufacture of cameras and photographic reproduction equipment. Phillips Chemical Co. is subsidiary to Phillips Petroleum Co., widely known in petroleum, natural gas and petrochemical fields, while the Borden Company, the responsible officials of which in this deal are not known, is a leader in dairy products and in plastics synthesis. The project is under careful study by a large engineering firm.



This Fluid catalytic cracker is going up in Llandarcy, Wales, designed by the M. W. Kellogg Company. It should be on stream by September, 1952.

Standard-Vacuum Plans Australian Refinery

Additional refining facilities for the manufacture of a full range of petroleum products for Australian and New Zealand consumers will be constructed at the Altona plant of Vacuum Oil Company Pty., Ltd., Standard-Vacuum Oil Company announced. The plans, in effect, call for a complete new refinery adjoining the present small lubricating and asphalt plant that has been in operation near Melbourne since 1949.

The new refinery will increase the present 2000-bbl-per-day capacity at Altona to more than 14,000 bbl per day. The project will include a modern catalytic cracker, distillation and treating units necessary for the production of motor gasoline, jet fuels, power kerosine, diesel oil, and fuel oil. Representing an investment of some $17,000,000, the new refinery will operate on Middle East crudes.

When completed, the new facilities at Altona will increase Australian refining capacity by 40 per cent and, including the refinery to be constructed at Durban, South Africa, will raise the Stanvac organization's refining capacity to more than 100,000 bbl per day.

To Collaborate on Study of Fats

The individual industrial organization can "split" its own fats, if it chooses, in collaboration with Distillation Products Industries, division of Eastman Kodak Co., that company has announced. Invitation is extended to manufacturers and producers of oils and fats to discuss the possibility of producing special monoesters to meet particular requirements. Any fat may be studied, the company said, and the Eastman subsidiary will esterify the fatty acids with glycerine and distill the monoester from the reaction mixture. Purities up to 90 per cent of the desired ester can be assured, and little if any glycerine wasted, it is claimed.

Continental Plant Makes Safety Record

Continental Oil Company's Ponca City, Oklahoma, refinery has completed 2,000,000 man-hours without a lost time injury. The accumulation of safe working hours, established by more than 1500 men working at various crafts, spans from mid-January of this year. Projected to a one-man basis, the 2,000,000 man-hours are equivalent to the Methuselah span of 969 years, alloting the Biblical figure a 40-hour week, without vacations, and extending from the age of seven to 969 years.

Continental's Lake Charles, Louisiana, refinery reached its first 1,000,000 man-hour mark without a lost time injury on June 1, 1951 and is now working toward the 2,000,000 goal.

Deep Rock Builds Blending Plant

Construction is scheduled to start immediately at Deep Rock Oil Corporation's Cushing refinery on a new blending and packaging plant for motor oils and greases, W. J. Carthaus, vice president, manufacturing and research division, announced today.

The chemical plants division of Blaw-Knox Construction Company has the contract for the refinery addition. It is expected that the new plant will be in operation late this year.

Capacity of Deep Rock's new facility will be 6,000,000 gal annually, which represents roughly one-third of the Cushing refinery's output of lubricating oils. The other two-thirds is sold in tank car lots to industrial users and compounders throughout the country.

New Type Gas Plant Begins Production

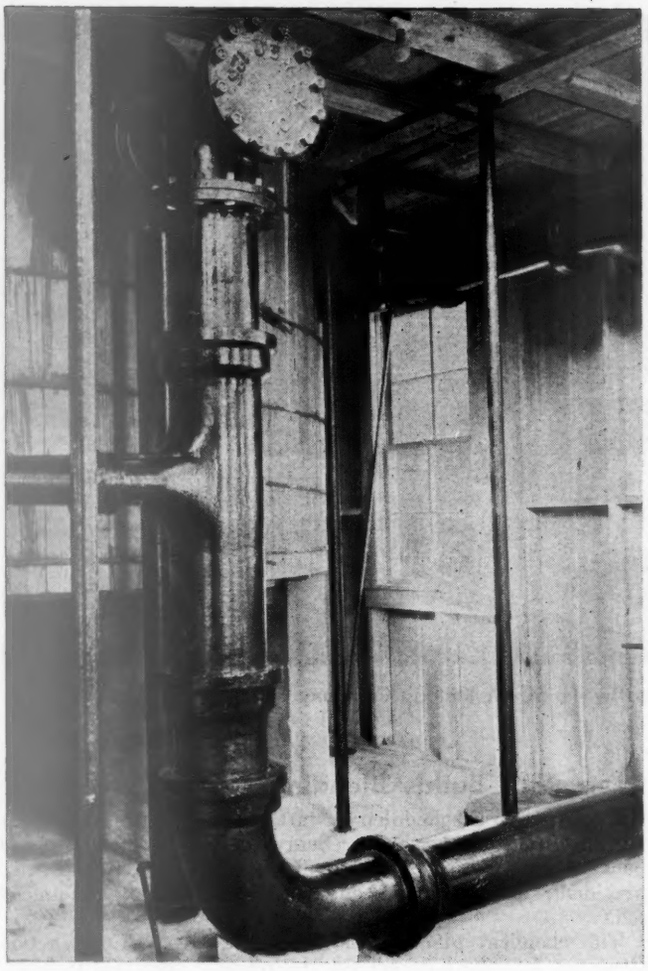
A new demonstration plant has been designed to produce more than 1,000,000 cu ft of city gas per day using gasoline, propane, butane, light oil, or natural gas as raw materials. It is known as the Koppers-Hasche process, and was built by the engineering and construction division of Koppers Company, Inc., which has world patent rights for this type of installation granted by Dr. R. Leonard Hasche, the chemical engineer who invented it.

With only minor changes in raw materials or production procedures, the process can be made to synthetically produce benzene, ethylene, and acetylene—all chemicals now greatly in demand in the plastics and other industries.

Heart of the Koppers-Hasche process is a thermal reforming furnace that may operate at varying degrees of temperature up to, and even above 2200 F. For producing city gas, it is operated in the 1500-1600 deg range. In the Rochester installation as it is presently being used, natural gas comes in from a large main, pressure is reduced to 5 psi, it is metered, and then flows through a valve that regulates its rate of flow. From here, it goes to a mixing chamber where it is combined with air in a normal proportion of 1 to 1. This mixture enters the furnace for treatment.

New Fuel Additive Available to Oil Industry

A new fuel oil additive that virtually eliminates filter screen clogging in domestic fuel oil burners is now being marketed by Shell Chemical Corporation. The new product, Ionad 17, will also be a boon to diesel engine operators. In diesels, Ionad 17 will reduce maintenance costs due to clogged screens and fouled fuel-injector parts, Shell Chemical reports.



DIRECT ROUTE TO LOWER PLANT MAINTENANCE

The direct and indirect expense of replacements of short-lived refinery pipe lines can be reduced, or avoided altogether, by the use of cast iron pipe. This has been proved by many refineries whose maintenance costs have been lowered by replacing other pipe materials with cast iron.

A relatively low first-cost material, cast iron pipe is usually cheapest in the end, for many refinery applications, because of its stubborn resistance to corrosion. Available with bell-and-spigot, plain end and flanged, or with standardized mechanical joints.

Cast Iron Pipe Research Association,
Thomas F. Wolfe, Engineer,
1015 Peoples Gas Bldg., Chicago 3, Illinois.

CAST IRON PIPE
FOR LONG LIFE AND ECONOMY

New Asphalt Company Set Up

Formation of a nationwide company for the manufacture and sale of various types of paving asphalts and special asphalt products was announced by Charles W. Stewart, president of American Bitumuls and Asphalt Company, formerly known as American Bitimuls Company.

American Bitumuls and Asphalt, which formerly operated only in the territory east of the Rocky Mountains, is acquiring the assets of Stancal Asphalt and Bitumuls Company, which has operated in the west. Both are subsidiaries of Standard Oil Company of California.

The organization will have fourteen district offices, including manufacturing plants and asphalt refineries in the United States and Puerto Rico. San Francisco is headquarters.

Other officers include vice presidents, L. G. Thompson, production and research; E. G. Lohmann, finance; N. H. Angell, western sales, and L. P. Street, eastern sales.

Southern Alkali Name Changed

The corporate name of Southern Alkali Corporation has been changed to Columbia-Southern Chemical Corporation. A wholly owned subsidiary of Pittsburgh Plate Glass Company, the firm is a producer of soda ash, chlorine, caustic soda, and related chemicals. Plants are situated at Barberton, Ohio; Corpus Christi, Texas; Natrium, West Virginia; Lake Charles, Louisiana, and Bartlett, California.

Clarence M. Brown, chairman of the board of directors for both Pittsburgh Plate Glass Company and Columbia-Southern Chemical Corporation, stated that the action involves a change in name only. He said that personnel, policies, and customer relations will not be affected.

B-A Refinery Gets Safety Award

The British American Oil Company's refinery in Moose Jaw, Saskatchewan, has completed four years of operation without a lost-time injury. For the fourth consecutive year the refinery staff of 120 will receive the company president's award of one additional day's pay as an acknowledgment of their outstanding contribution in the field of safety.

A. N. McGrath, safety supervisor of the Moose Jaw refinery, presented the checks at a special gathering held at the plant.

Man-hours worked by the Moose Jaw refinery employees during the 1460 days totalled 955,107. B-A initiated an intensive safety program several years ago and employs a full-time safety supervisor in every refinery. The Moose Jaw refinery is presently being modernized and expanded. When the construction work is completed next year the plant will have a daily processing capacity of 15,000 bbl of crude oil.

Caltex to Construct Fuel Plant in Lebanon

California Texas Oil Company, Ltd., plans to construct in Lebanon, near Sidon and the western terminus of the Trans Arabian pipeline, a plant for the manufacture of diesel and fuel oils.

This plant will be constructed and operated under an agreement with the Lebanese government. Diesel and fuel oils will be for local consumption in Lebanon and for Caltex bunker requirements only.

Total estimated cost is $5,800,000 to cover the purchase of land and the projected plant, at a capacity of 13,000 bbl per day. The plant is scheduled for completion within a period of approximately 24 months.

Phillips Gasoline Plant Underway

Phillips Petroleum Company has begun construction on its Spraberry natural gasoline plant in Midland County, Texas, which will initially process 1,000,000 cu ft of gas per day.

The plant site has been purchased and surveys are partially completed for pipe lines and other field facilities. Considerable equipment is already available and Phillips has received the necessary governmental approval to purchase all other required materials.

The new plant will serve principally the Tex Harvey, Germania, and Driver areas in Midland and Glasscock Counties. As field developments continue the plant will be extended proportionately to handle all additional gas discovered.

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Effective, positive treatment for phenol, cyanide and other noxious industrial wastes—without excessive installation and operating costs—is now available through the Mathieson Chlorine Dioxide Process. Existing installations, handling both large and small waste volumes, attest to the efficiency and economy of this treating method.

Mathieson's Chlorine Dioxide Process

* Low Capital Investment

A Chlorine Dioxide system to handle an average waste output can be installed for $2000-$3000, and amortization charges are negligible. The equipment consists only of a small holding tank, a chlorine dioxide solution generator and the metering equipment for the chlorine and sodium chlorite solutions.

* Simple Installation

The Chlorine Dioxide system, being extremely compact, can be quickly and easily fitted into the disposal facilities. No special housing is necessary to contain the equipment.

* Minimum Maintenance

The simplicity of the Mathieson Chlorine Dioxide equipment minimizes maintenance and no special technical supervision is required for operation. The chlorine dioxide is fed automatically at the predetermined rate for safe, positive control.

Mathieson's background of experience, accumulated over many years in the field of sanitation is available to you. Write for information about the Chlorine Dioxide Process. Mathieson Chemical Corporation, Baltimore 3, Maryland.

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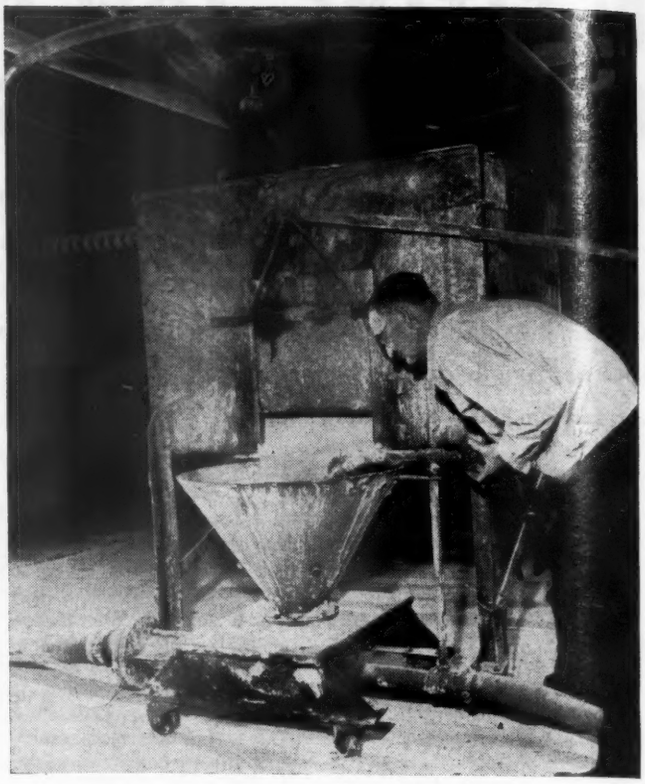

Moving Spent Clay to Settling Basin

Engineers at the Marcus Hook, Pennsylvania, refinery of Sun Oil Company solved a materials handling problem by eliminating manual operation and decreasing the time required to convey spent clay from filter shells to a settling basin outside the building.

A Schutte and Koerting hopper type eductor was mounted on a movable platform with the hopper situated above and the eductor below the platform. When it is necessary to remove spent clay from any one of 10 filter shells, a movable secondary drum, or hopper, is rolled under the man-head of the filter shell to receive the spent clay. A gate in the secondary hopper is regulated to permit the proper amount of clay to feed into the eductor hopper.

Pressure water, by-passed from the inlet line on the eductor, issues through the wash down nozzles in the eductor hopper and washes the clay down into the eductor chamber. Then pressure water, which issues through the nozzle of the eductor, entrains the clay and discharges through the flexible hose with sufficient force to carry the clay-water slurry to the settling basin.

Pan-Am to Build Coker At Louisiana Refinery

The first major unit for production of coke from petroleum crude oil in the Gulf Coast area will be constructed by Pan-Am Southern Corporation at its Destrehan, Louisiana, refinery. The unit will produce each month about 20,000,000 lb of coke vitally needed for aluminum production.

Roy J. Diwoky, Pan-Am's executive vice president, announced that a contract has been signed with The Lummus Company, designing engineers and constructors for the petroleum industry, to build the coker.

The coker, 240 ft tall, is the second such unit to be built by Pan-Am Southern. The company finished its first coker at its El Dorado, Arkansas, refinery last fall in a construction program that took less than one year.

The Destrehan coker will be so designed to process either heavy crude oil or the "heavy bottoms" from an adjacent refining unit processing light crude. The facilities will charge approximately 9000 bbl daily of these feed stocks and will convert this heavy material into gasoline, light gas oils and coke. The primary purpose of the coking unit is to produce high yields of gas oil which may be further processed in the catalytic cracking unit to high octane aviation or motor gasoline.

Chemical Firm Executives Promoted

Dr. C. R. Wagner, formerly vice president for operations of General Aniline and Film Corp., has been promoted to senior vice president, Jack Frye, General Aniline's president, has announced. John C. Franklin was elected vice president of operations for General Aniline Works, the dye and chemicals division of the company.

President Frye also announced that arrangements to obtain a loan of $20 million from a large insurance company have been completed, to continue with the company's expansion program which has involved about $30 million already since World War II ended.

Dr. Wagner is known widely in the petroleum refining chemical industries, and is one of the leaders in the American Chemical Society and the Synthetic Organic Chemical Manufacturers Association. Franklin was formerly head of General Dyestuff Corp., sales company for chemical products and dyes for the parent company, and is well known, especially for his work as manager of Oak Ridge Operations for the Atomic Energy Commission until 1949.

Sunray to Build $10 Million Refinery

Approval by the Defense Production Administration of a certificate of necessity for Sunray Oil Corporation to build a new 25,000 bbl per day capacity catalytic cracking refinery at Corpus Christi, Texas has put finals plans for the project on engineers' drawing boards, it was announced by the board of directors.

The new Sunray refinery is to be constructed in conjunction with the company's present deep water crude oil terminal facilities and crude oil tank storage of 1,330,000 bbl at Corpus Christi and vicinity, and the Sunray Coastal Pipe Line Company's crude oil pipe line gathering system from Placedo to Corpus Christi. Sunray's coastal pipe line facilities will be capable of delivering 20,000 bbl daily into the refinery and another 10,000 bbl is available from Sunray owned or controlled production which can be delivered into the refinery through facilities of other Texas crude oil carriers.

India Requests Refineries

Burmah Shell, Standard-Vacuum, and California Texas companies are considering India's request that they build oil refineries there in view of the Middle East oil crisis. Spokesman for a leading U. S. firm stated that even if the plan were received favorably it was doubtful that sufficient steel could be obtained.

Three years ago, a six-man committee, formed under the government's Petroleum Advisory Committee and including foreign experts, visited sites for refineries in a three-month tour of the country. Nothing has been done about it since.

New Aviation Gasoline Additive

Safer, more efficient operation of airplane engines by reducing the rate of failure of aircraft spark plugs may be made possible by a new aviation gasoline ingredient announced by James H. Doolittle, vice president of Shell Oil Company.

"This additive not only will cut the loss of time and money due to the grounding of planes for unscheduled replacement of spark plugs, but it will also make engines more reliable," Doolittle said.

Spark plug fouling, or failure to fire, is caused by gradually-accumulating deposits that electrically conduct across insulated parts of the spark plug, short-circuiting it. If both plugs in a cylinder cease firing, serious engine vibrations may set up.

The new ingredient reduces fouling by changing the nature of the deposit so it remains non-conductive.

Petro-Chem Offices Move

The Petro-Chem Development Company, engineers and erectors of furnaces and superheaters used in the refining of oil and processing of chemicals, has rented a large portion of the 15th floor of the Chanin Building, New York City, on a long-term lease. Presently situated at 120 East 41st Street, New York City, the Petro-Chem Development Company plans to move their executive and sales offices to the Chanin Building, 122 East 42nd Street, in November of this year.

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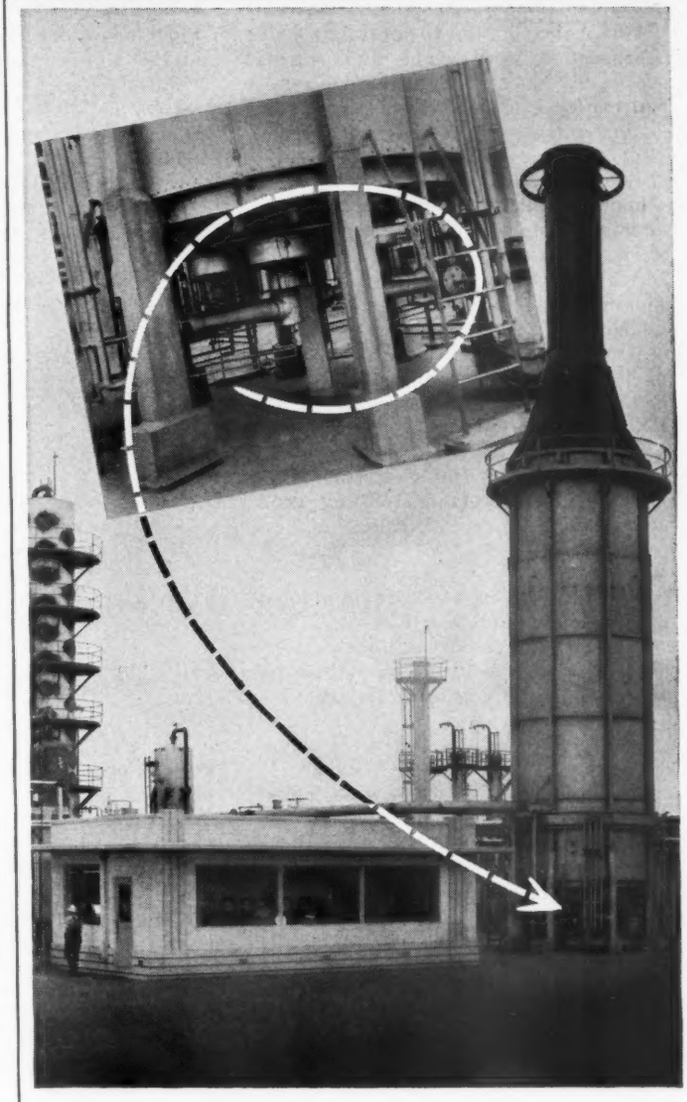

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—PERSONALS—

Randal Maass, Palos Verdes, California, is leaving the General Petroleum Corporation, with which he has been associated since 1934, to become assistant manager of one of the largest petroleum refineries in the Far East. He has been assigned to Standard-Vacuum Petroleum Maatschappij's refinery at Palembang, Sumatra, in the Republic of Indonesia. Maass will leave for Holland shortly to visit the SVPM office there for a period of orientation. After a month in Holland he will go on to Palembang.

A graduate of the California Institute of Technology where he won three letters in football, Maass joined General Petroleum as a laboratory technician in 1934. He worked as a laboratory chemist, a gas engineer and as a refinery engineer before becoming assistant manager of the company's Torrance (Calif.) refinery in 1949.

William Kaplan has been appointed director of the automotive research laboratory for Pan American Refining Corporation. He will reside in Baltimore, Maryland, the location of the automotive laboratory.

Kaplan recevied his degree in chemical engineering in 1927 from M.I.T. and went right to work in the oil industry. In 1941 he was employed by the research department of Pan American Refining Corporation. His latest position in the Texas City laboratory was as section chief in charge of technical service.

William K. Conn, Philadelphia, Pennsylvania, and **J. West Loveland,** Buffalo, New York, have joined the staff of Sun Oil Company's research and development department at Marcus Hook, Pennsylvania. They recently completed their doctorate work at Pennsylvania State College.

Sterling E. Voltz and **Hiroshi Shimizu** have joined the Research Division of the Houdry Laboratories, Linwood, Pennsylvania. Dr. Voltz recently received his Ph.D. in physical chemistry at Temple University. Dr. Shimizu received his Ph.D. in metallurgy at the University of Utah.

Two recent promotions at the Houdry Laboratories are **Heinz Heinemann** as section leader in charge of process research and **E. R. Boedeker** as section leader in charge of exploratory research.

Dr. Curtis F. Gerald

Dr. Curtis F. Gerald has joined the engineering, research and development department of Universal Oil Products Company, Chicago. Dr. Gerald, formerly associated with Universal at its Riverside, Illinois, laboratories, returns to the company after an absence of four years, during which time he served as an assistant professor of chemical engineering at the University of Washington, Seattle.

From 1942 to 1947 he was employed as a research chemical engineer with Universal. He is a graduate of Iowa State College and holds graduate degrees from University of Cincinnati and Massachusetts Institute of Technology.

Collected around a corner table at Shell Chemical's Torrance plant cafeteria for breakfast September 6 were: Walter Havekorst, president-elect of the Long Beach Chamber of Commerce; C. T. Furrer, Standard Oil Company; Martin Voogd, Shell Chemical Corporation; Cliff Beyers and Al Hynes, Shell Oil Company; and D. W. Campbell, general manager of the Long Beach Chamber. Occasion was the monthly breakfast meeting of the Chamber's Armed Service Committee.

Louis D. Mann

Louis D. Mann has been elected president of Cities Service Refining Corporation. Mann succeeds **Burl S. Watson,** who was recently made chairman of the corporation's executive committee.

Mann is a veteran Cities Service executive. He joined the organization in 1917 soon after receiving his B.S. from Union College. He began work as a chemist and advanced rapidly through various refinery positions.

During World War II he was manager of the Cities Service Defense Corporation, Maumelle Ordnance Works at Little Rock, Arkansas. Since 1946 he has been vice president and general manager of Cities Service Refining Corporation which operates the giant Tutwiler refinery at Lake Charles, Lousiana.

J. W. Barber, superintendent of Phillips Chemical Company's Philblack plants at Borger, Texas, will be assigned to the Philblack sales division as rubber service engineer. Barber recently returned from an extended assignment in England, in connection with the start up of operations of the Philblack, Ltd., plant.

Succeeding Barber as superintendent of Philblack plants will be **A. J. Head,** who has been acting superintendent during Barber's absence.

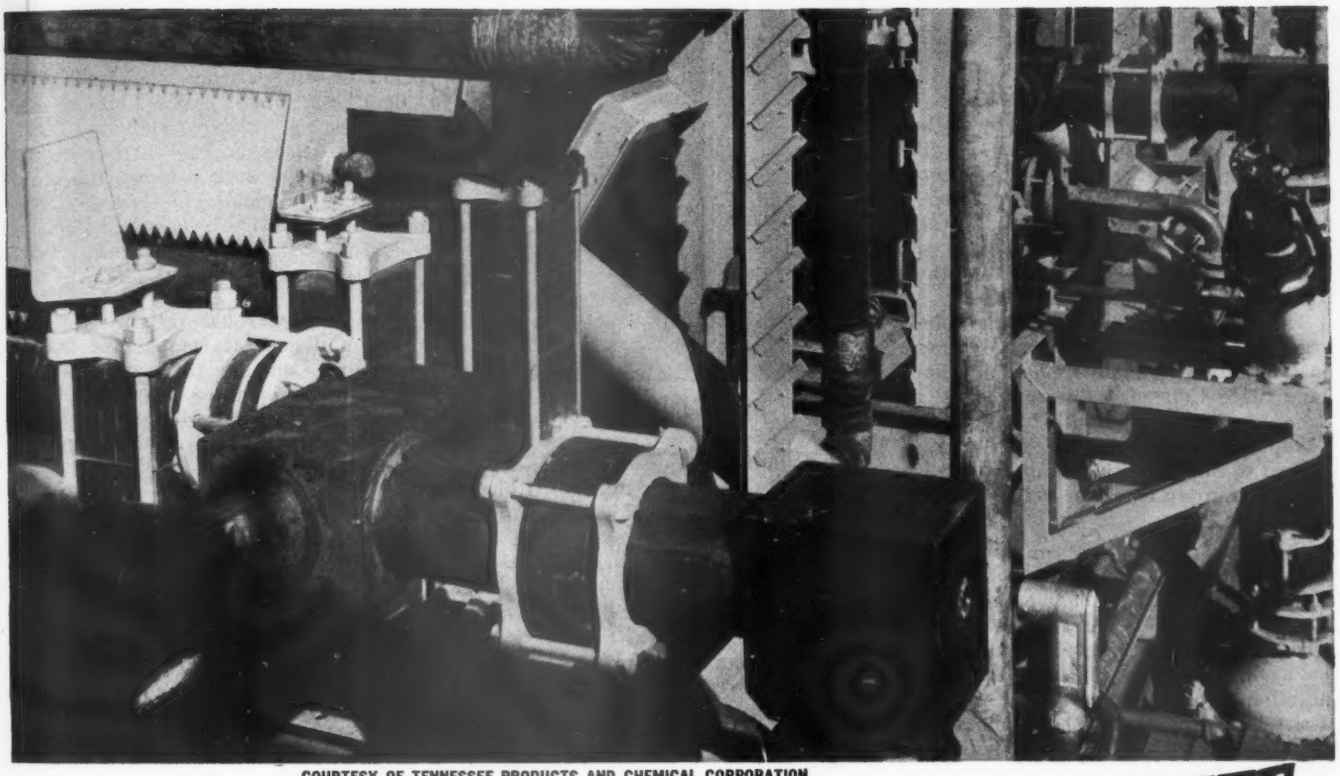
Austin Morgan, services superintendent at Plains plant, at Borger, will be assigned to the newly-created position of assistant chief mechanical engineer in Bartlesville. **H. H. Stoelzle,** acting mechanical and maintenance superintendent at Plains plant, will succeed Morgan as services superintendent.

M. L. Studebaker, consulting chemical engineer in the process engineering division, will be assigned to the Philblack sales division as technical service engineer, with headquarters in Akron, Ohio.

John T. Ragsdale, Jr., well known to the oil industry through his years of work in connection with oil additives and other chemicals employed by the industry, has been made head of a new market research and product development section of Monsanto Chemical Co.'s Organic Chemicals Division, the section to be responsible for product specifications development of chemical intermediates outside the resin field and to carry on research in markets.

QUESTION:

What pipe handles ALL corrosives?



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★ **When you use "Karbate" impervious graphite, you don't need to use a variety of corrosion-resistant materials.**

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PLUS FACTORS OF "KARBATE" IMPERVIOUS GRAPHITE PIPE:

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John A. Bolt has been promoted to division director, light oils and special products, in the Standard Oil Company (Indiana) research laboratory at Whiting, Indiana. Formerly assistant superintendent of technical service, he succeeds **Dr. Philip C. White,** who has become manager of research and development for Pan American Refining Corporation at Texas City, Texas. **H. M. Hart,** group leader in the research laboratory at Standard's Sugar Creek, Missouri, refinery, has been promoted to assistant superintendent of technical service at Whiting.

Bolt joined Standard in 1930 as a chemist at the Whiting laboratory. He became a group leader in 1944 and assistant superintendent of technical service in 1947. Bolt did his undergraduate work at Calvin College, Grand Rapids, Michigan, and received his master of science degree in chemistry from the University of Michigan.

Hart became associated with the company as a chemical engineer at Whiting in 1940 following graduation from Montana State College. After service as a group leader with Utah Oil Refining Company from 1943 to 1945, he returned to Standard Oil Company (Indiana) as a group leader at Sugar Creek.

Richard P. Porter has been appointed to the product development staff of Ethyl Corporation. A plant pathologist, Porter will assist Dr. Charles L. Smith, who is in charge of development work on agricultural chemicals for the Corporation. Porter's duties will be to assist in the development of new agricultural chemicals, to participate in field tests and cooperative work with experiment stations, and to acquaint organizations in the field with Ethyl's growing activities in agricultural chemicals. He received his BS degree from the University of Connecticut and an MS from Virginia Polytechnic Institute. He is a member of the American Phytopathological Society.

Joe Wood, chief chemist, Skelly Oil Company, Pawhuska, Oklahoma, has been appointed chairman of the Technical Committee of the Natural Gasoline Association of America, according to a recent announcement by NGAA president, John F. Lynch, president, La Gloria Corporation, Corpus Christi, Texas. Wood succeeds H. A. Montgomery, Warren Petroleum Corporation, Houston, who served as chairman of the committee for three years. **J. L. Thompson,** research engineer, Lone Star Producing Company, Dallas, was named vice chairman of the committee.

Wood will also direct the LP-Gas subcommittee investigation of odorants, which may prove more effective as warning agents in domestic service than those presently used. It is probable that an extensive research program will be undertaken as a result of current studies. **Dr. E. H. Koepf,** Atlantic Refining Company, Dallas, was named chairman of the High Pressure Absorption Committee and **A. J. Miller,** Phillips Petroleum Company, Bartlesville, will continue to direct activities of the Fractional Analysis subcommittee. The latter group is working on improvements in analytical methods to obtain more accurate results, the studies being made with the cooperation of 58 oil company and commercial laboratories. The Plant Control Test subcommittee is headed by **K. C. Bottenberg,** Phillips Petroleum Company.

Dr. Vladimir Haensel

Dr. Vladimir Haensel, Universal Oil Products Company, Chicago, Illinois, was named as the 1952 recipient of the Precision Scientific Company's award for achievement in petroleum chemistry. Announcement of the $1000 citation was made at a Diamond Jubilee meeting of the American Chemical Society in New York. The award, which is administered by the American Chemical Society, will be presented to Dr. Haensel sometime next spring.

The 37-year-old chemist is the inventor of the Platforming process, which is currently being accorded wide acceptance throughout the petroleum refining industry. Platforming is a new process for refining gasoline which employs platinum as the catalyst to rearrange the molecular structure of motor fuel.

Platforming units are now in operation, under construction, or planned at more than 20 refineries, with approximate capacity of 100,000 bbl daily.

Dr. Haensel graduated from Northwestern University in 1935 and holds graduate degrees from there and Massachusetts Institute of Technology.

Wayne A. Proell and **Dr. A. W. Weitkamp** have been promoted to research associates in the Standard Oil Company (Indiana) research laboratory at Whiting, Indiana. Proell joined the company in 1938 as a research chemist at Whiting. He has done extensive research on petrochemicals, particularly in the field of sulfur derivatives. He was graduated from the University of Chicago.

Dr. Weitkamp, who became associated with the company in 1937 as a research chemist, has carried out fundamental studies on the composition of fatty acids and the mechanism of hydrocarbon synthesis. He did his undergraduate work at Midland College, Fremont, Nebraska, and received a Ph.D. from the University of Nebraska.

Elvin Odell Campbell has joined E. I. du Pont de Nemours & Company's petroleum-chemicals division. He began his duties as manager of the Mid-Continent district laboratory in Tulsa, Oklahoma, October 1. He was formerly the chief of the standards and specifications section of the technical branch, Munitions Board, petroleum division.

W. C. Dickerman, Jr., has been transferred to London by the Lummus Company, to serve as sales engineer for The Lummus Co., Ltd, there. Dickerman has had wide experience in American refinery and allied construction and sales engineering, being employed after graduation from Yale University and post-graduate work at Massachusetts Institute of Technology; then with Pure Oil Co. for 7 years; he joined Lummus, then worked for Houdry Process Corp., and rejoined Lummus last year.

D. W. Hovey has resigned as president and general manager of Danaho Refining Company to become an independent oil operator. **Raymond P. Elledge, Jr.,** succeeds Hovey as president. **C. W. Curtis** has been appointed general manager of the firm.

Frank E. Johnson has joined Phillips Petroleum Company, Bartlesville, Oklahoma, research and development department as process engineer. He was formerly process engineer for Cities Service Refining Company at Lake Charles, Louisiana.

Willis Morgan, formerly administrative assistant to the manager of British American Oil Company's refinery in Calgary, Alberta, Canada, has been transferred to the company's Moose Jaw, Saskatchewan, Canada, refinery as assistant manager.

D. S. Simmons has been appointed superintendent of Imperial Oil's Montreal East Refinery. Simmons was formerly manager of Imperial Oil's engineering division, Sarnia. He received his B.Sc. from Queen's University in mechanical engineering, has served as a draftsman, technical superintendent, and in 1946, chairman of manufacturing technical committee for Imperial. From that position he went to assistant manager of the engineering and development division, becoming manager in 1950.

Paul W. Taylor has been transferred from plant foreman at the Kenova Gasoline Plant near Smackover, Arkansas, to plant foreman at the Hickok gasoline plant at Ulysses, Kansas.

Haskell Alspaugh has been promoted from district meterman in the Panhandle district to assistant foreman in the Kermit, Texas district for Magnolia Petroleum Company. **Frank O. Fidler** has been promoted from assistant foreman at the Seeligson gasoline plant to plant foreman in charge of the Kenova gasoline plant at Smackover, Arkansas.

Bus for transporting workmen to and from the job. This is a standard make chassis upon which a special body was built.

Use of Trucks in the Pipe Line Industry

Many and varied are their functions in the construction and operation of the oil and gas industry's lifelines

FRANK H. LOVE*

EXCLUSIVE

POSSIBLY the truck has been taken too much as a matter of course and not enough written of its vital importance in a vital industry. One pipe line contractor made this statement: "I think it is reasonable to say that the modern truck has contributed as much to the advancement of pipelining as any other piece of equipment. Certainly it has advanced the speed of operations."

The truck has done much more than that for pipelining. To present in a more detailed manner the many and varied pipe line function of trucks and accessory equipment, this article was conceived, the recorded facts coming from those closest to the subject, the people who use them — contractors, stringers, and supervising personnel of gas and oil operating companies.

As a matter of simplification and because, by virtue of their operations, they have somewhat different set-ups, the discussion will consider separately the use of trucks by contracting firms and pipe line operating companies.

Use by Contractors

The uses for trucks in pipe line construction work are limited only by the

Entire X-ray equipment needed for testing welds is mounted on this one truck for ready portability along the pipe line.

*Editor, Oil and Gas Pipelining.

Stringing pipe along the right-of-way.

ingenuity of the men who operate them. Typical of these uses is the following listing for one spread of a major contractor:

1. Right-of-way brush gang—one ½-ton truck.
2. Right-of-way dozers — one 2-ton truck with winch, and one ¾-ton pickup with radio.
3. Hand ditch — one ¾-ton pickup and one jeep.
4. Machine ditch—one ¾-ton pickup with radio.
5. Bending gang—one ¾-ton pickup and one jeep.
6. Pipe gang—three 2½-ton trucks, two ¾-ton pickups, one 2-ton truck with winch, and one 2-ton truck without winch.
7. Welding gang—one ½-ton truck with winch, one ¾-ton truck with winch, and one 2-ton truck.
8. Coating—four 2-ton trucks (two with winch) and one ¾-ton truck with radio.
9. Lower-in gang—one 2-ton truck with winch, and one ¾-ton truck with radio.
10. Cleanup gang — one power wagon, one 2-ton truck with winch, and one ¾-ton truck with radio.
11. Overhead—one ½-ton truck, one ¾-ton truck with radio, two ¾-ton trucks without radio, one 2-ton, one 3-ton tractor-type, one 2½-ton, four 2-ton, one 10-ton truck with winch and lowboy, and one float.

The foregoing enumeration, in addition to showing distribution of trucks among the several construction crews of a pipe line spread, also gives a good idea of the truck sizes that are in most prevalent use.

These trucks are used for transporting personnel to and from the job; hauling various supplies from the warehouse to the construction gangs; for transporting utility welding equipment, and in some instances firing line welding equipment; hauling fuel, water, skids, pipe cutting equipment, and stringing pipe, to mention those services that come most readily to mind. Then, of course, their role is indispensable when moving the field office, warehouse stock, and equipment from one location to another.

Certain automotive equipment of a more special kind is sometimes employed also. There is the use of trailers as field offices by some contractors. In these trailers are kept the business records of the job, and when the field office is to be moved to another location, it is only necessary to lock the door, hook the trailer onto a car, and leave; all of which can be accomplished in a period of 30 minutes or less. Opening up for business at the new location is equally simple and rapid.

Contrary to what might be thought, pipe line trucks are ordinarily stock cars and not specially built for this duty. In some instances, it is true, a special body may be built on a standard chassis for transporting personnel. Sometimes, too, operating personnel may build their own "doghouse" or a

Welding machine mounted on truck at double-jointing yard in Mississippi.

Trailers of this type are used by some contractors as field offices. They house all business records of the job, and the field office thus can be moved to a new location quickly and with minimum effort and confusion.

Nowadays all contractors equip their trucks with 2-way radio, enabling working crews to keep in touch with each other and with the field office. Here a driver calls in to the central dispatcher.

Operation and Maintenance

The hard usage to which trucks are subjected in the pipe line industry is indicated by the high truck mortality rate when compared to the national average. Figures released by the Automobile Manufacturers Association reveal that the average age of general purpose trucks in use throughout the United States is 7.4 years. The average life of the pipe line truck is considerably less—approximately 2.5 years, as determined by a survey among construction contractors and operating companies.

It naturally follows that pipe line trucks must be kept in top mechanical condition. General practice is to maintain a repair shop in the city where the contractor has his headquarters, and it is universal policy to overhaul all equipment during winter shut down. When work is in progress, however, most of the company mechanics are out on the job, shops being established at spread headquarters. In some instances it is necessary to use local garages for repairs and overhauling.

In addition to providing the best in mechanical care, pipe line contractors

flat bed truck, and winches, ginpoles, and such equipment are added after the truck has been purchased, but basically trucks are stock equipment. Some operators expressed the opinion that this should not be the case, that the ruggedness of the pipe line industry warrants improvements by manufacturers upon present equipment. Among the suggestions for improvement are: Higher centers, extra heavy duty rear ends, additional lower gears, front wheel drives, improved rear springs, heavier tires, and stronger steering mechanism. In short, many believe there should be heavy duty trucks manufactured especially for pipe line work.

In New York State the winters can get rough. Trucks often have to use special snow-grip tires.

are careful that their trucks have whatever "extra" equipment is required. Some do not consider special tires necessary, but a majority equip their trucks with oversize, heavy duty tires, usually of the mud-grip variety. Incidentally, it is of interest to note that the average life of a set of pipe line truck tires is from four to six months, varying with the number of miles driven, of course, and the condition of the terrain in which they are used.

On the other hand, the consensus is that special brake linings are unnecessary. There are exceptions, however, and some contractors insist on heavy duty linings.

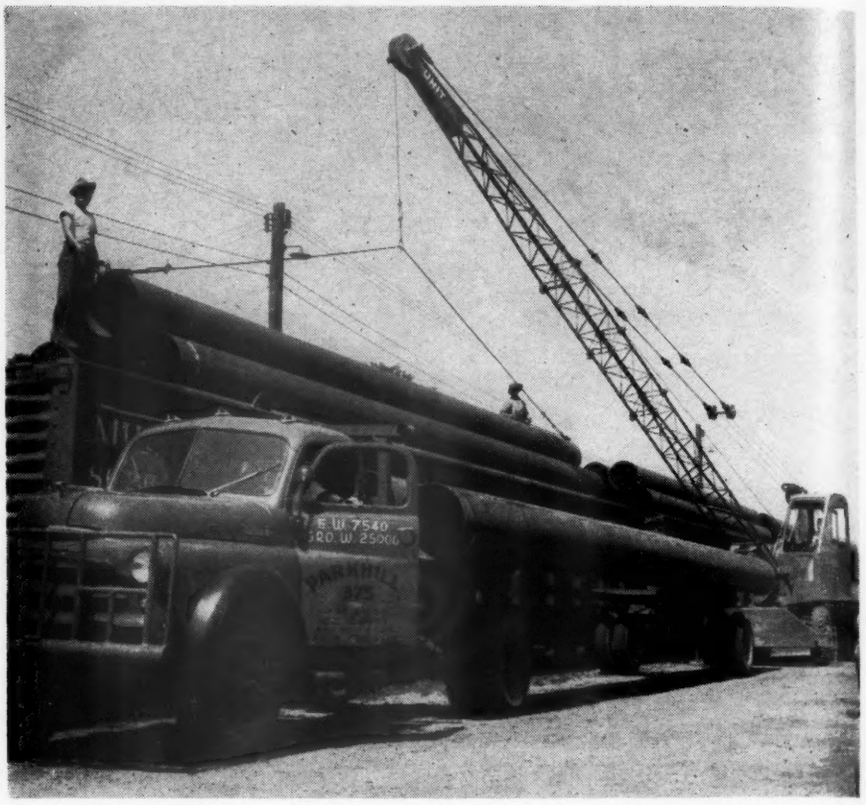
Truck Records

With a heavy investment in trucks—a single contractor frequently owns more than 200 trucks—obviously a good set of records must be kept. Such records include data to show where the trucks are situated, and to whom assigned, at a given time, cost analyses for repairs and depreciation, etc.

A truck driver's daily log is another type of report partially, not universally, required. The form commonly used is that prescribed by the Interstate Commerce Commission. When properly filled out this accounts for virtually every minute of the driver's day. The report is made in duplicate and the original kept on file at main headquarters for a period of one year. The duplicate is kept by the driver for a period of one month.

The truck drivers themselves, like all pipeliners, are an individualistic and rugged lot. Generally speaking, they are paid better than drivers in other industries. Some belong to labor unions, some do not, the determining factor in a large sense being geographical. Few important labor troubles are reported and this doubtless is due to the fact that pipe line truck drivers are well paid. Too, most of them have pipelining in their blood, and that is a virus hard to eradicate.

The nature of pipelining does not assure the truck driver of employment the year 'round. Usually, however, pipe line jobs are numerous and keeping employed is largely a problem of moving from one place to another. Infrequently during the winter months when there are fewer projects underway, he may have to take an enforced 'vacation' without pay. All contractors carry insurance on their men to compensate for lost time due to accidents, to pay hospital bills, and to care for their employees' families in event of death.



Unloading 40-ft lengths of pipe from a railroad car onto stringing truck.

Even the rugged stringing truck sometimes comes to grief. Through no fault of its own, this one overturned on the tricky terrain of East Texas.

Truck Purchase Policy

Actual purchase of trucks and appurtenances is effected principally through the main office of the company. The decision regarding what brands of trucks to buy usually is made at the main office, but there is considerable latitude in this regard. In almost an equal number of instances, superintendents are permitted to specify what kind of trucks they prefer and of what manufacture. Some superintendents are even given the privilege of arranging purchases in the area where they are working at the time.

It might be supposed that price would be the principal factor in determining what make of truck to purchase. More often than not it isn't. There apparently exists the desire on the part of purchasers to keep an open mind and take into account other factors first. The truck's suitability for the job is the primary consideration, but, after that, a good "deal" isn't to be overlooked. Along this line, all contracting firms have a national fleet agreement that makes it possible to effect a

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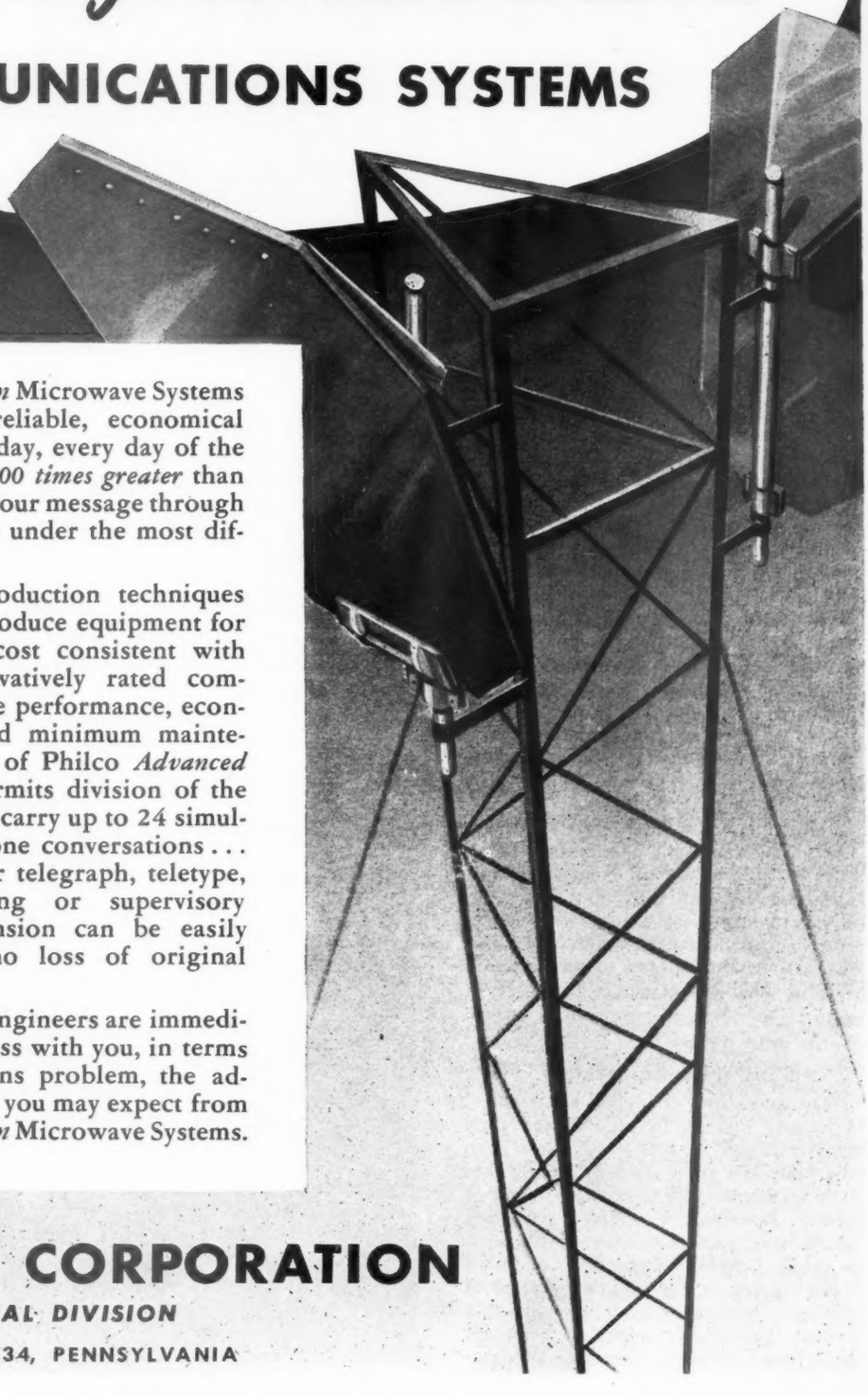

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Trucks are called upon to operate in all kinds of weather—struggling through the sticky Texas mud.

savings whether a truck is purchased at the main office or by a superintendent anywhere in the United States. This same kind of agreement also is used in the purchase of tires and parts.

Retirement of trucks is determined almost entirely on the condition of the vehicle, rather than upon the length of time it has been in service or the number of miles driven. Usually the superintendent decides when a unit is to be replaced and makes his report to the main office, or, in some instances he is authorized to replace the equipment on his own initiative. The procedure for disposing of retired trucks varies. Sometimes they are traded in on new units, sometimes sold outright, whichever method is more advantageous.

Although a few contractors state that they are attempting to standardize on one or two makes of trucks, this has not been accomplished in a single instance to date to the writer's knowledge. It is a common sight when visiting a major pipe line spread to see as many as 8 or 10 different makes of trucks in use.

Stringing Contractors

The pipe line stringing contractors' principal task is to unload line pipe from railroad cars and transport it to the pipe line right-of-way. Usually this is a comparatively short haul, but not always. Sometimes the pipe is unloaded and moved to a central yard where it is stacked, if it is to be double-jointed before going to the right-of-way, or if for some reason the general contractor cannot immediately begin work on the line. In addition, the stringing contractor does a certain amount of equipment hauling. Not so many different kinds of trucks are needed for this type of work as in the case of the general pipe line contractor. Trucks consist entirely of stock car cabs with pole trailers. Special equipment that must be added include bolsters, fish-plating, winch, headache post, heavy duty tires, and a fifth wheel. In some localities mud-grip tires are necessary. Incidentally, a set of tires used by a stringing contractor will last 30 to 45 days, depending on the terrain traversed.

Stringing trucks range in size from 1½ tons to 5 tons, the 1½-ton and 2½-ton being most prevalent. The life of such a truck is estimated at 1½ to 2 years.

A repair shop is maintained at company headquarters for general overhaul and major repairs. Each gang has a mechanic for making minor repairs, and sometimes private garages in the vicinity of the work are utilized.

Because of the more or less simplified operation involved, truck purchases are handled entirely by the home office, where it is decided what make of trucks shall be purchased and when a unit shall be replaced.

Various makes of trucks are used, and price does have some influence on what will be bought. When a unit is retired it may be either sold outright or traded in on a new one. All companies operate under a national fleet agreement for the purchase of trucks, tires, and parts.

Part 2, which discusses the use of trucks by pipe line operating companies, will be published in an early issue.

Records are kept on operating and repair costs. In some cases a record is kept for each truck, in others the records are by the job.

Drivers of stringing trucks must have special training for their jobs. It is obvious that this would be so because of the long trailers heavily loaded with pipe that must be hauled over all kinds of roads and terrain. A driver is trained by working him first in a gang where he can become familiarized with operations. He is then allowed to drive at intervals, and when finally accustomed to his duties, to take over full time.

* * *

Transporting ditching machine overland by truck to a new pipe line location.

Centrifugal Compressors for Pipe Lines

A discussion of the principles of operation, performance, and construction of this newer type of gas booster equipment.

C. F. KOENIG, III

TREMENDOUS increases in the demand for natural gas throughout the country have brought a newcomer, the centrifugal compressor, to work on the gas pipe lines. This newcomer has caused quite a stir in the industry as it is radically different in size, appearance, and operation from the reciprocating compressors, which have been used heretofore for this pumping service. This article will discuss principles of operation, performance, and construction of De Laval centrifugal compressors designed for this new service.

The centrifugal compressor is by no means a new machine. It was originally an outgrowth of the centrifugal pump and has been around for a good many years. It is now used in a great variety of industrial processes where air or other gas must be compressed, exhausted, or circulated; it has been used since the First World War for supercharging internal-combustion engines, and since the Second World War in jet engines and gas turbines. It is now coming into prominence as a gas pipe line pressure booster. The centrifugal compressor may be driven by steam turbines, gas turbines, electric motors, or gas engines. Of these prime movers the steam turbine and the gas turbine are new to pipe lines, and offer exciting possibilities in high outputs and flexibility of operation.

Principles of Operation

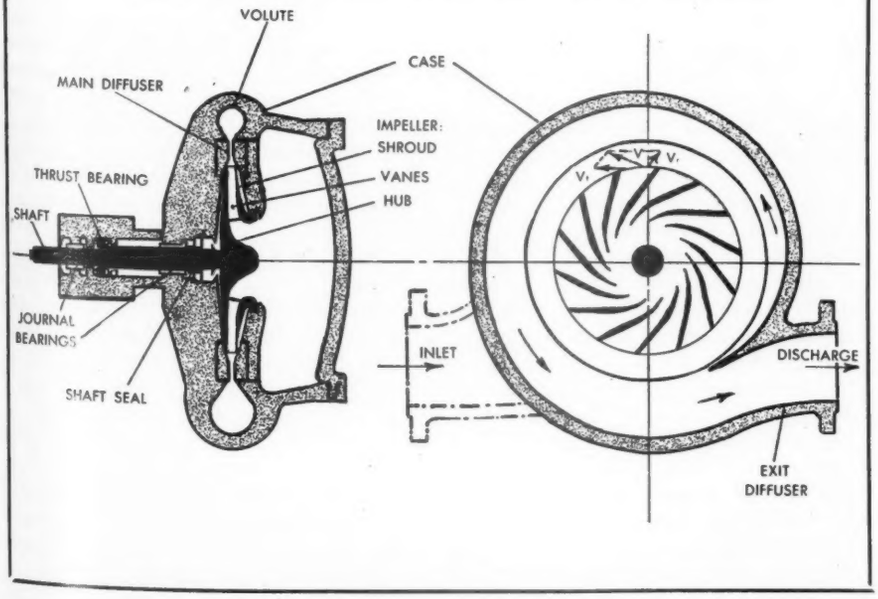
The centrifugal compressor is a "turbomachine", which is a general term applied to that class of fluid machinery wherein work is done upon, or extracted from, a fluid entirely by the dynamic action of blades, channels, and guiding surfaces that come in contact with the fluid as it passes through the machine. There is no physical "squeezing" of the fluid as in the case of a positive displacement compressor and, as the flow is continuous, there is no sequential operation of valves. Fig. 1 shows schematic longitudinal and radial section drawings of a typical centrifugal pipe line compressor, with the important elements labeled and with arrows added to indicate the direction of gas flow through the machine.

EXCLUSIVE

The Author

C. F. Koenig, III, has been with De Laval Steam Turbine Company since 1947. He is employed in the compressor department, which is concerned with the development and design of pipe line compressors. Upon his graduation from Princeton University in 1940, Koenig joined De Laval and Turbo Engineering Corporation, working in the design and development of aircraft turbo-superchargers. He spent three years in the Navy as a flight test project engineer, and upon his discharge in 1946 joined Westinghouse in the aviation gas turbine division.

FIG. 1. Schematic sections of centrifugal pipe line compressor.



Gas is taken into the compressor through a side opening on the compressor case, whence it flows into a plenum chamber on the suction side of the rotating impeller. The impeller consists of a steel hub or disk which is keyed to the shaft, a number of vanes attached to this hub, and a shroud or sideplate fastened to the outer edges of the vanes. Gas enters the impeller through the annular opening between the shroud and the hub and is "scooped up" by the vanes, which are arranged at angles calculated to result in minimum entrance shock losses. From here the gas is forced outward through the channels formed by the vanes, hub, and shroud and is discharged at the outer periphery of the impeller with a small velocity component V_r in the direction of the vanes and a large velocity component V_t in the tangential direction. As indicated by the velocity diagram in Fig. 1, the resultant of these two components is a high velocity V directed away from impeller at an acute angle from the tangential direction. When the gas leaves the impeller, all work of compression has been done and the total pressure (static plus dynamic)

is at its highest value in the machine. The compression up to this point, on the basis of total pressures, is normally accomplished at an efficiency greater than 90 per cent. The velocity of the gas leaving the impeller is several hundred feet per second, however, and before the compression can be considered complete this high velocity stream must be decelerated to convert the major portion of its velocity pressure into static pressure.

Immediately outside the impeller periphery is the main diffuser, a stationary guiding element that does the lion's share of decelerating the high velocity stream being discharged from the impeller. In most compressors for pipe line applications, this diffuser consists simply of a deep, narrow chamber formed by essentially radial sidewalls. As shown in Fig. 1, these sidewalls converge somewhat just outside the impeller, then are parallel or nearly so through the remaining depth. The diffuser shape is determined by the flow condition leaving the impeller and is calculated to give the highest possible efficiency in converting velocity head to static pressure. The optimum sidewall shape may vary somewhat in different compressors, as will the radial depth of the diffuser chamber. For this reason, the sidewall contours are formed on separate rings, which are then bolted into the case. This construction simplifies machining operations and also allows modifications to the impeller and diffuser for varying flow requirements without changing the complicated and expensive case casting.

Following the diffuser is the volute, or scroll collector. This element serves the purpose of collecting the flow that issues from the diffuser in a 360-deg arc and directing it into a single discharge pipe. The shape and size of the volute passage take into account the vortex nature of the flow, providing for further gradual deceleration as the mean radius of the passage increases. After the volute passage has completed a complete circuit of the diffuser and all the flow is collected, a second diffuser is provided for final deceleration of the flow before it reaches the discharge flange. This final diffusing passage is directed so that the discharge flange will be in line with the suction flange, an important consideration in pipe line station layout.

The compressor shaft is supported in two pressure-lubricated sleeve bearings and is so proportioned that its lowest critical speed is substantially above the maximum operating speed of the compressor. A double-sided Kingsbury thrust bearing is provided to withstand the large end forces on the rotor due to unbalanced gas pressure. These end forces are in the direction of the coupling at starting and at low speeds, then reverse as the compressor comes up to operating speed and develops a pressure differential between the impeller inlet and discharge.

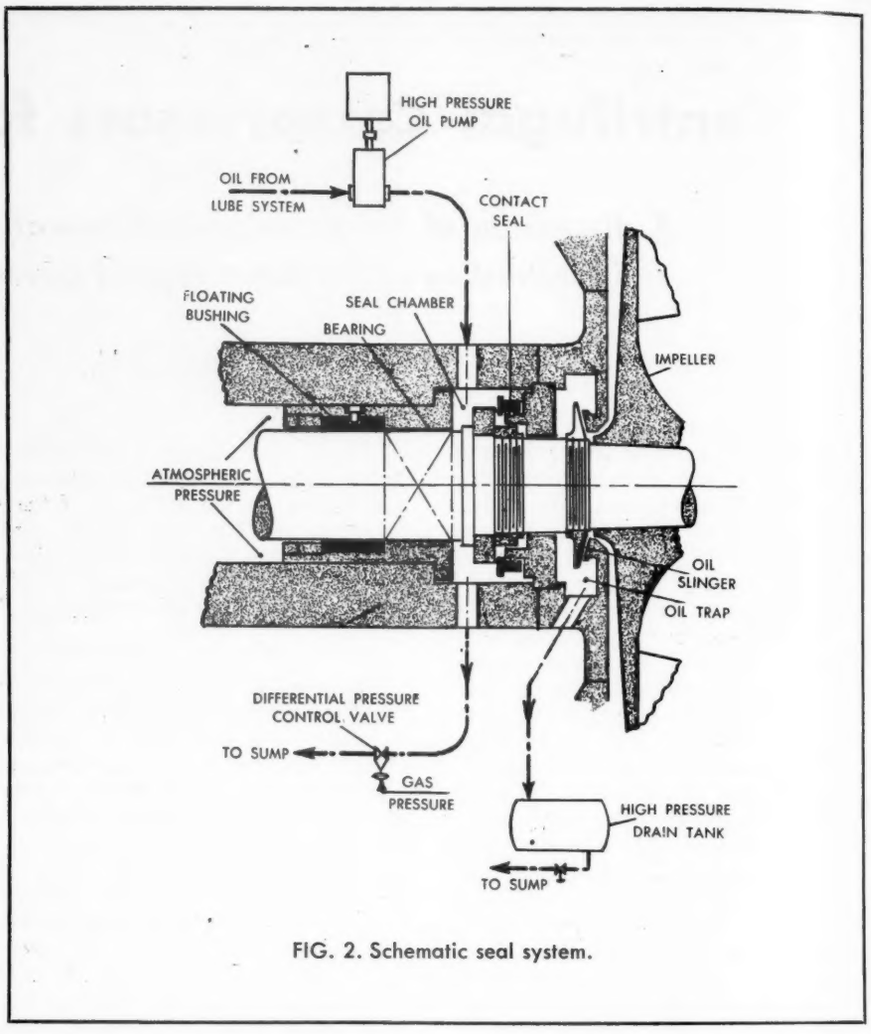


FIG. 2. Schematic seal system.

Gas is prevented from escaping along the shaft to atmosphere by an oil-operated, differential pressure seal system. In principle, this system consists of a seal chamber surrounding the shaft between compressor case and atmosphere, which is kept filled with oil at a slightly higher pressure than the gas pressure in the compressor case. No gas can enter the seal chamber because the oil pressure is always higher than the gas pressure, hence no gas can escape through the chamber to atmosphere. As a perfect seal is practically impossible on a high-speed rotating shaft, there is some oil leakage from the seal chamber, but this leakage is kept to a minimum by contact seal elements, by close-clearance "floating" bushings, or by a combination of the two.

The seal system presently used in De Laval pipe line compressors is illustrated schematically in Fig. 2. Oil is taken from the compressor main lubricating system and raised to a high pressure by a motor-driven or by a main-shaft-driven De Laval IMO pump. This high pressure oil is fed continuously to the seal chamber, whence some of it leaks out along the shaft and the remainder is bled off through a differential regulator valve that keeps the seal chamber oil pressure always slightly higher than the gas pressure in the compressor case. A contact seal is employed between the seal chamber and the compressor case, whereas a close-fitting floating bushing is used between the seal chamber and atmosphere. Oil leakage through the contact seal is usually of the order of 500 cc per hr., or about 3 gal per day. This small leakage is caught in a slinger and trap arrangement and is drained into a high pressure tank, which is emptied into the main oil sump periodically. Oil leakage through the floating bushing at typical operating pressures is from 2 to 4 gpm, but this leakage goes directly to an atmospheric drain and presents no particular drainage problems. As shown in Fig. 2, the inboard journal bearing may be so arranged that it is lubricated by the oil leakage through the floating bushing.

Performance

In any discussion of compressor performance, the fundamental point of interest must always be the power required to pump a given quantity of gas through a given pressure ratio. The theoretical, or isentropic, power required can, of course, be calculated from specified conditions, and the efficiency of the compressor then determines what actual horsepower must be delivered to the compressor shaft. Fig. 3 is a curve arranged for quick determination of compressor horsepower required per million standard cubic feet of gas per day over a range of pressure ratios normally encountered in centrifugal compressor stations. The design compressor efficiency upon which this curve is based is 83 per cent. As the number of units is increased the overall efficiency decreases slightly, as indicated by the shift in the curves. This is a very useful curve for general estimating purposes and for determining the number of compressors required for a particular station where the overall station pressure ratio and the driver horsepower are known.

The performance of an individual compressor may be described for any specified gas conditions in the terms of pressure ratio, flow in standard cubic feet per day and horsepower, the variables used in Fig. 3. To obtain a clear picture of actual compressor performance, however, it is necessary to transform the flow into actual volume flow at the inlet to the machine (CFM), the pressure ratio into head (H), or work done per pound of gas pumped, and the power into efficiency (η), or the ratio of isentropic power to actual power. In these terms curves can be drawn that show performance of the compressor over its entire range of speed and flow. If we go one step further and plot these variables as percentages of their values at a "design point," we obtain the curve shown in Fig. 4, where the design point corresponds to the 100 per cent values of each variable. The advantages of using inlet volume, head, and efficiency in a compressor performance plot stem from the fact that curves do not change with variation in inlet temperature, inlet pressure, and specific gravity of the gas. This statement is not strictly accurate if the variations are very large. For example, in comparing the performance of a compressor pumping air at atmospheric pressure to the performance of the same blower pumping gas at several hundred pounds pressure, there are minute but measurable changes due to a different sonic velocity and to Reynolds number changes in the compressor. These effects are negligible, however, for any possible variations in gas conditions in pipe line operation.

By using percentages instead of actual values, a further generalization is accomplished by eliminating the dimensions of the compressor. Thus a curve of this type can be used for the same compressor operating under different gas conditions, and it may further be used for different size compressors of the same type, so long as the design point be known for each compressor considered. As a typical example in laying out a series of compressor stations along a pipe line, it usually happens that the gas flows and station inlet pressures vary somewhat from station to station, resulting in different design points for each station. A single curve similar to Fig. 4 would be used in computing the performance of all of these compressors.

Notwithstanding the general utility of the volume-head-efficiency curve, it is sometimes desirable to plot the performance of a particular compressor in terms of horsepower, pressure ratio, and standard cubic feet per day. This is readily done by using the general curve of Fig. 4 and applying the following relations:

Flow in standard cu ft per day:

$$Q_s = 1440 \frac{Q_1}{Z} \frac{P_1}{P_s} \frac{T_s}{T_1}$$

Pressure ratio:

$$r = \left[1 \frac{H}{Z R \frac{k}{k-1} T_1} \right] \frac{k}{k-1}$$

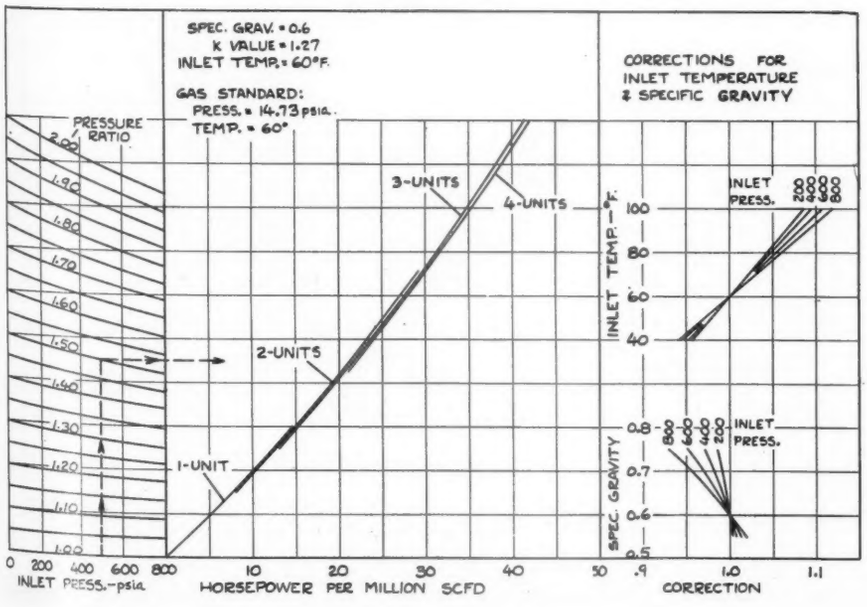
Horsepower:

$$hp = \frac{3.0325}{10^6} Q_s \frac{P_s}{T_s} \frac{T_1 Z}{\eta} \frac{k}{k-1} \left(r^{\frac{k-1}{k}} - 1 \right)$$

The symbols used above are defined as follows:

Q_s = flow, std cu ft per day
Q_1 = flow, cu ft per min
Z = supercompressibility factor
P_s = standard pressure, psia
P_1 = inlet pressure, psia
T_s = standard temperature, deg. F abs. (= deg. F 460)
T_1 = inlet temperature, deg. F abs.
r = pressure ratio
H = head, ft-lb per lb of gas
R = universal gas constant = 1545/molecular weight
k = ratio of specific heats
η = compressor efficiency, isentropic horsepower/actual horsepower

FIG. 3. Power requirements for single stage centrifugal compressors.



Centrifugal Stations

The centrifugal compressor is inherently a high-capacity, low-pressure-ratio machine. These characteristics lead to a different compressor station arrangement from that normally employed in reciprocating compressor

From these computations various types of curves can be obtained, which may be useful in visualizing the performance of a compressor under a particular set of operating conditions. An example is shown in Fig. 5, where the discharge pressure and the inlet temperature are assumed constant and the variations of pressure ratio and horsepower with flow are plotted for several speeds. In such a curve it is important to note all specified operating conditions and gas properties, because without these data the curve is meaningless.

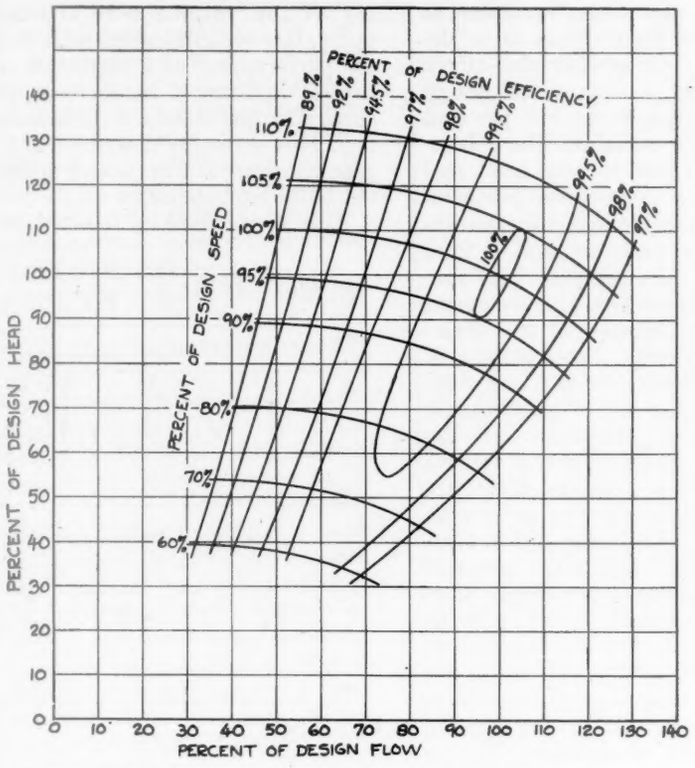


FIG. 4. Performance of single stage centrifugal compressor.

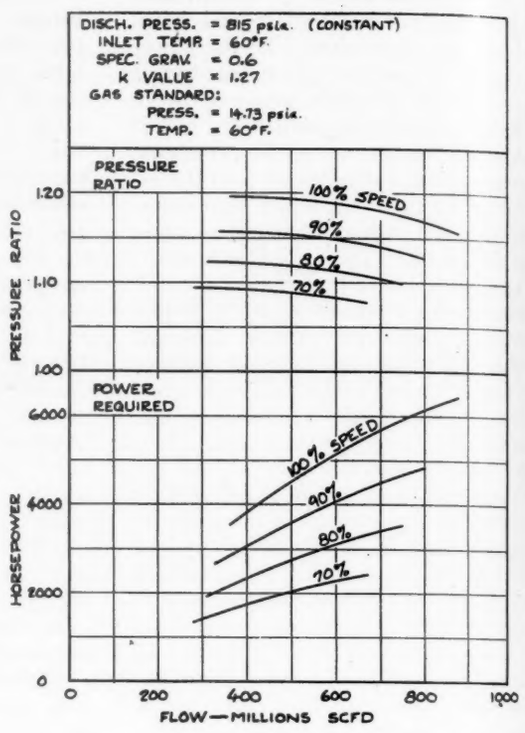


FIG. 5. Performance of compressor under specified conditions.

FIG. 6. Three-unit compressor station.

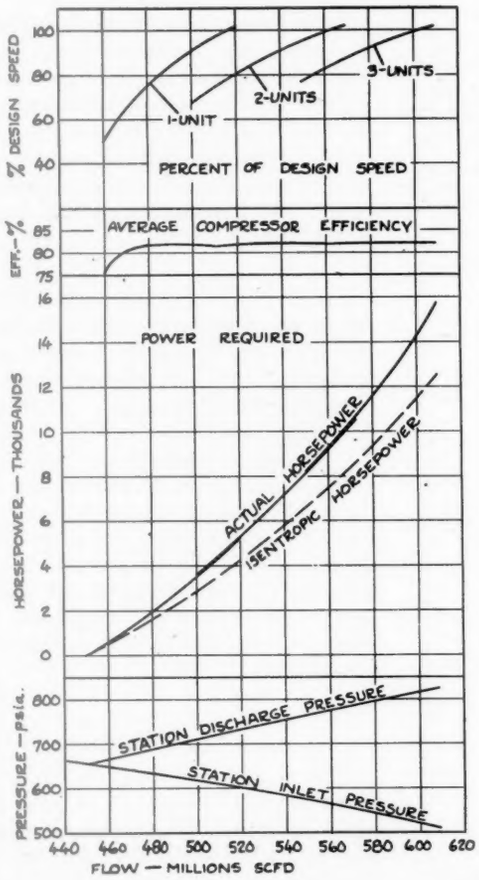
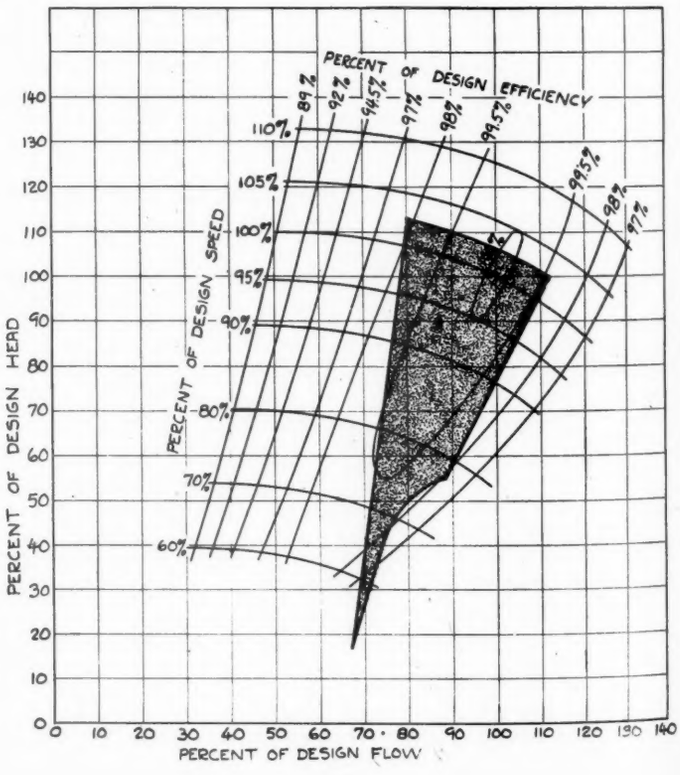


FIG. 7. Operating range for 3-unit compressor station.



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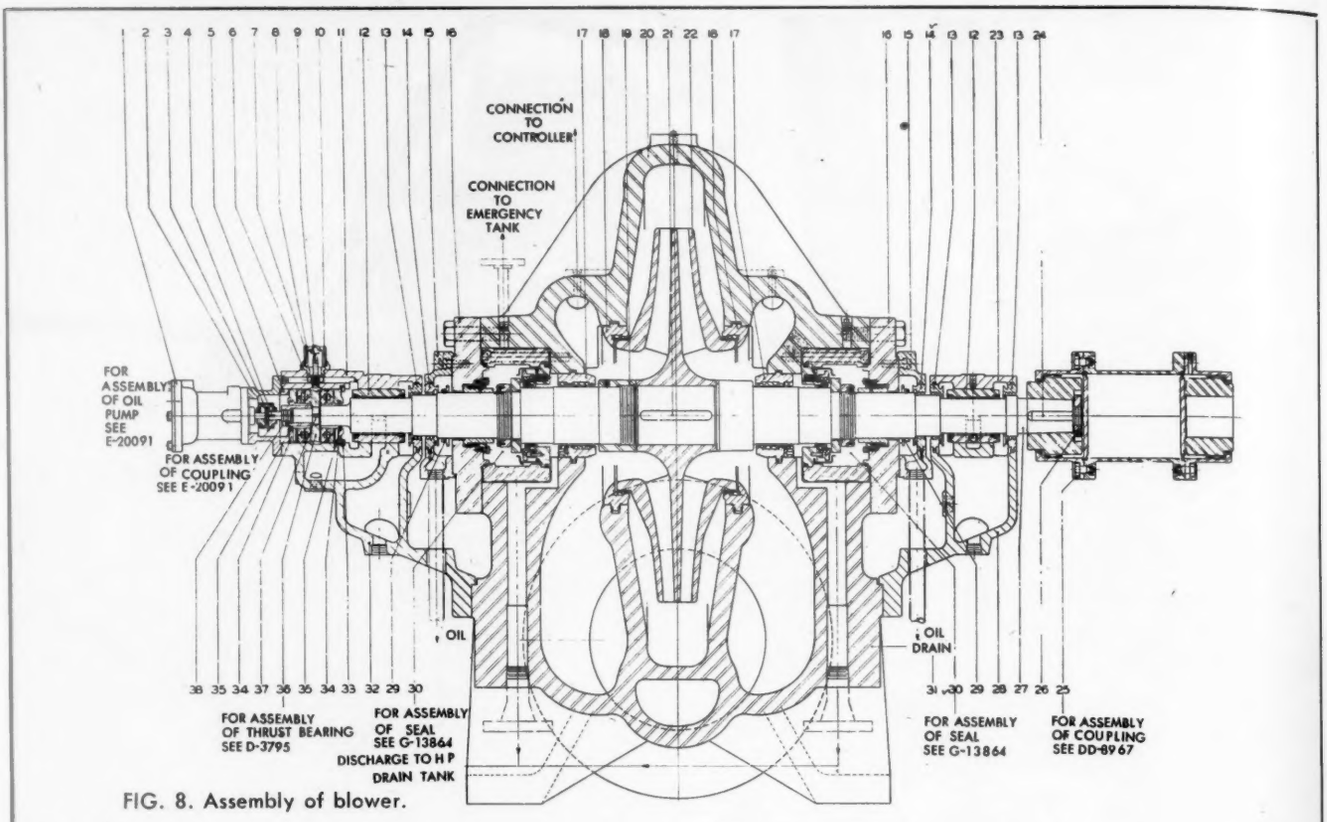
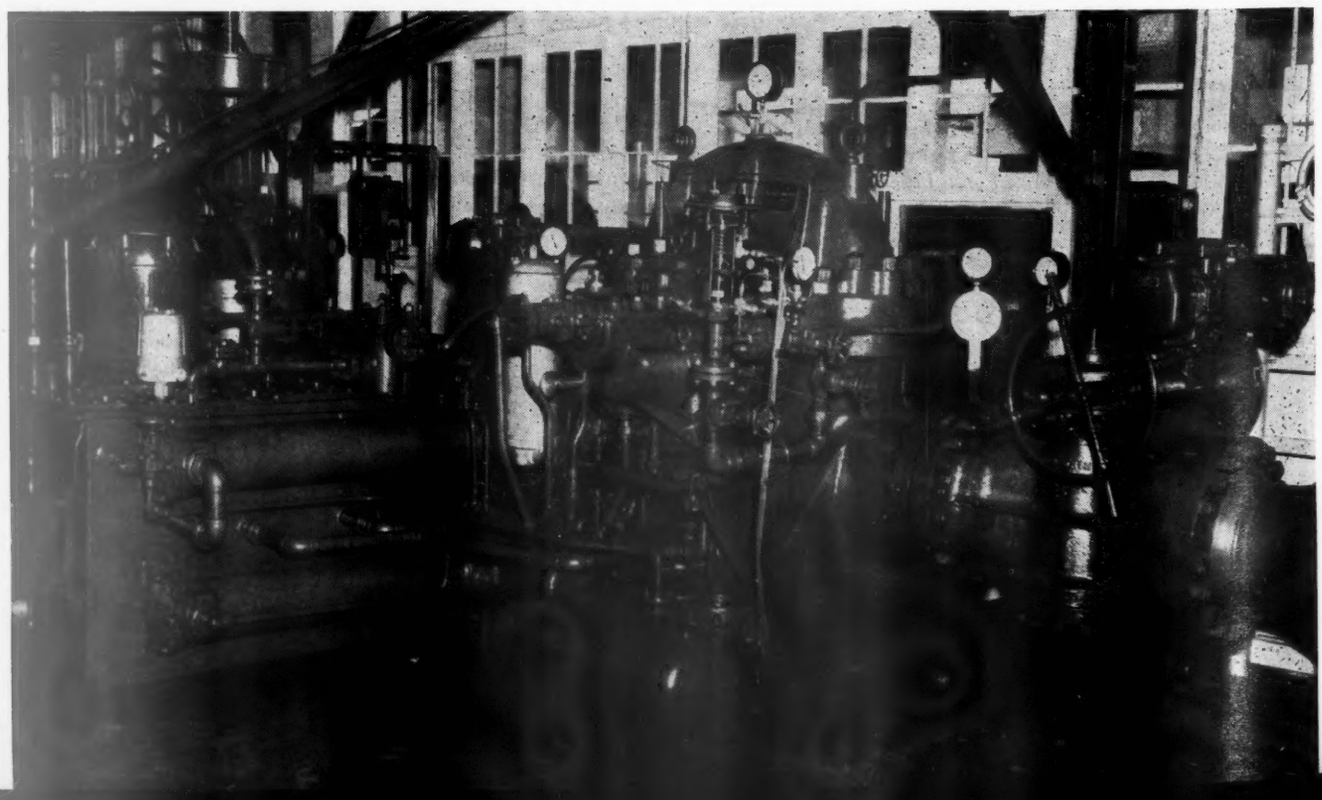

CONNECTION TO CONTROLLER
CONNECTION TO EMERGENCY TANK
FOR ASSEMBLY OF OIL PUMP SEE E-20091
FOR ASSEMBLY OF COUPLING SEE E-20091
OIL
OIL DRAIN
FOR ASSEMBLY OF THRUST BEARING SEE D-3795
FOR ASSEMBLY OF SEAL SEE G-13864
DISCHARGE TO H P DRAIN TANK
FOR ASSEMBLY OF SEAL SEE G-13864
FOR ASSEMBLY OF COUPLING SEE DD-8967

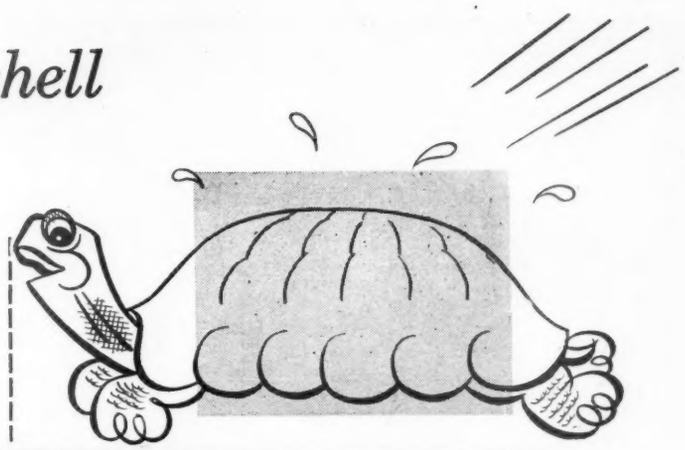
FIG. 8. Assembly of blower.

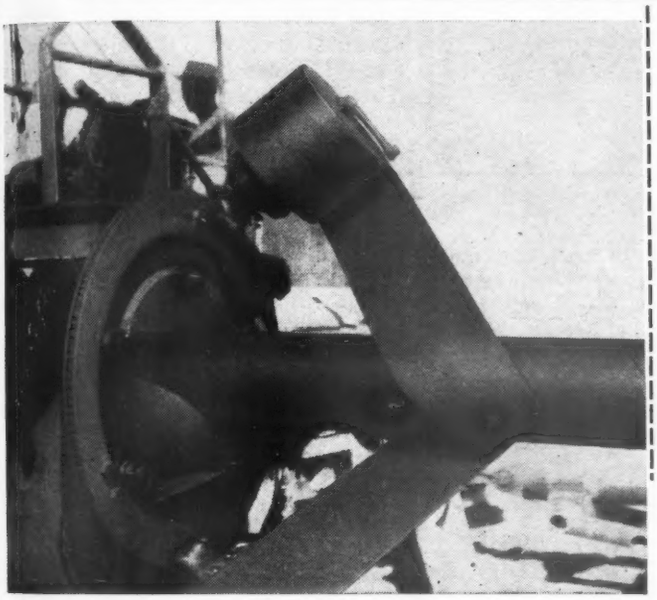
Pt. No.	Qty.	Symbol	Description	Material	Ft. No.	Qty.	Symbol	Description	Material
1	1	478	Oil Pump Case	Semi-St.	20	1	612	Blower Case Cover	Steel
2	1	487	Oil Pump Support	C. I.	21	1	642	Key	Steel
3	1		Oil Pump Coupling	Steel	22	1	777	Blower Wheel	Steel
4	1	#3	Woodruff Key	Steel	23	1	2086-1	Bearing B'k't. Cover	C. I.
5	1	298	Spacer	Steel	24	1	442	Key	Steel
6	1	323	Oil Sight Feed	Bronze	25	1		Coupling	Steel
7	1	326	Gage	Pyrex	26	1	443	Check Nut	Steel
8	1	327	Washer	Rubber	27	1	426	Blower Shaft	Steel
9	1	325	Oil Tube	Steel	28	1	2085	Bearing Bracket	C. I.
10	1	317	Cover	Bronze	29	2	588-3	Oil Slinger	Steel
11	1	2086	Bearing B'k't. Cover	C. I.	30	2		Seal	
12	2	395	Bearing	St. & Babbitt	31	1	512	Blower Case	Steel
13	3	588	Oil Guard	Bronze	32	1	2085-1	Bearing Bracket	C. I.
14	2	558-1	Oil Guard	Bronze	33	1	298	Shim	Steel
15	2	588-2	End Cover	C. I.	34	2	1189	Thrust Bearing Ring	Steel
16	2	1100	End Head	Steel	35	2	588-4	Oil Guard	Bronze
17	2	2041	Tightening Ring	C. I. & Babbitt	36	1	4 3/8	Kingsbury Thrust Bearing	
18	2	2083	Case Ring	C. I. & Babbitt	37	1	442-1	Key	Steel
19	1	2032	Check Nut	Steel	38	1	2032-1	Check Nut	Steel

FIG. 9. One of the compressor units installed in the Texas Eastern Transmission Corporation's Station No. 17.



Like the turtle's tough shell that protects him so well...





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Johns-Manville Asbestos Felt is a sturdy product. It is resistant to rot and decay, and to acid and alkali soils. It has both the thickness and the toughness necessary for shielding pipe line enamels from damaging earth loads and soil stresses. These advantages make it possible for the protective enamel pipe coating to function properly against corrosion.

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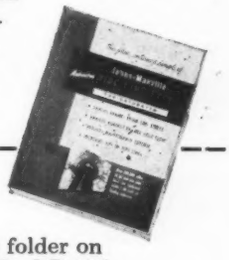

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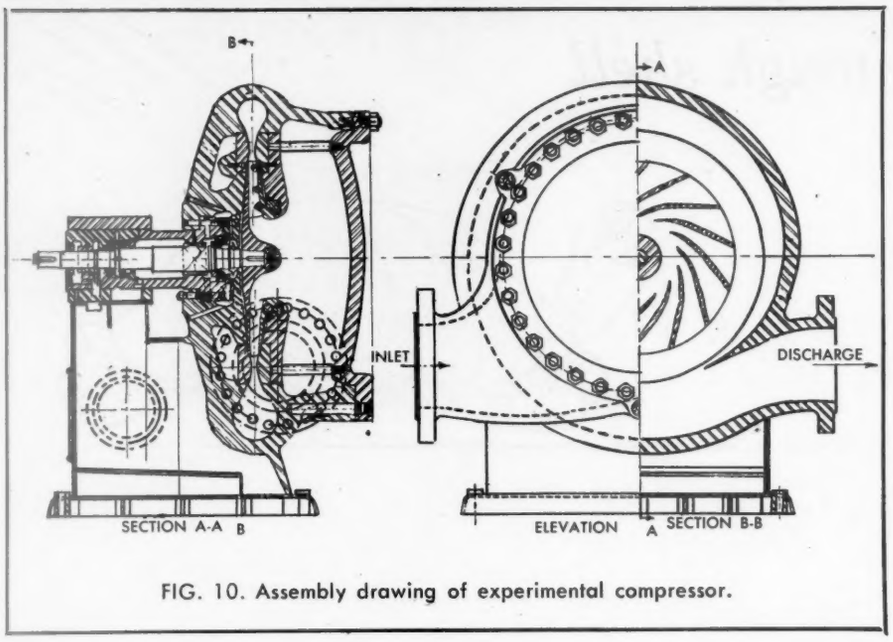


FIG. 10. Assembly drawing of experimental compressor.

stations. Where reciprocating compressors develop the entire station pressure ratio in each machine and are operated in parallel, each passing a part of the total flow, centrifugal compressors develop only a part of the station pressure ratio in each machine but operate in series, passing the total flow through each machine. Because required station pressure ratio decreases as the flow through the line decreases, this series operation lends itself admirably to changing loads. With variable speed drivers any station pressure ratio from the full design value to unity may be obtained by reducing the speed of the compressors and by taking individual compressors off the line as required.

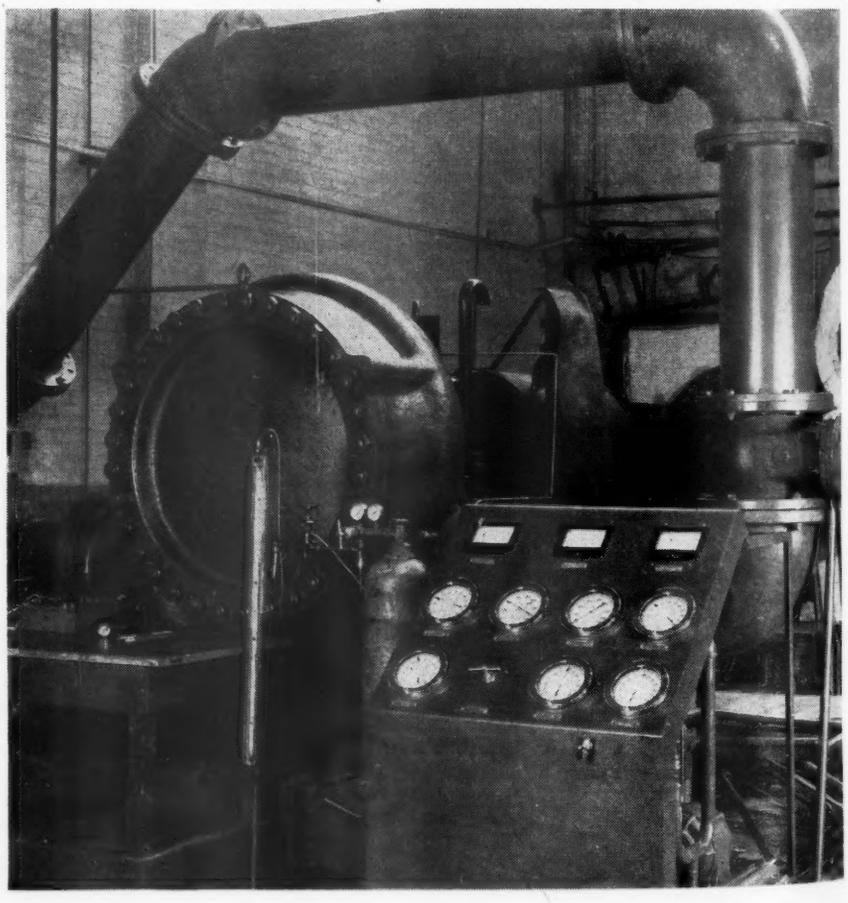
To illustrate this flexibility of operation, calculations have been made to show the operation of a typical three-unit centrifugal compressor station. Fig. 6 shows the station inlet and discharge pressure, the isentropic horsepower (power at 100 per cent compressor efficiency) the actual horsepower required, the average efficiency of the compressors and the speed of the compressors, all plotted against the flow through the station. The performance of the compressors was determined from the general curve of Fig. 4, and Fig. 7 shows the same curve with a shaded area to indicate the operating range covered by the three compressors for the station requirements of Fig. 6. The right side of the shaded area of Fig. 7 is the operating line for the first compressor when all three compressors are operating, whereas the left side of the shaded area is the operating line when only one compressor is operating. It is observed that excellent compressor performance is obtained over the entire operating region except in the extreme lower end, where only one compressor is operating at low speed and low power. To avoid operating inefficiently at this low load it is usually possible to shut the station down entirely and increase the horsepower slightly in an adjacent station in order to maintain the flow.

Appearance and Construction

The first pipe line compressors built by De Laval in 1948 were double suction machines with a horizontally-split casing. Fig 8 is an assembly drawing of this machine and Fig. 9 shows one of the units installed in the Texas Eastern Transmission Corporation's Station No. 17. The performance and mechanical operation of these compressors were and are quite satisfactory, but it was considered that improvements could be made in the design in the interests of economy and simplicity.

Late in 1949, a new design was developed and an experimental prototype was built for test. Fig. 10 is an assembly drawing of this machine, and Fig. 11 shows the compressor on test. The impeller is of the single suction type and is "overhung," thus requiring only one shaft seal. The compressor case is split vertically and has a matching end cover, which is bolted to the case. The matching surfaces in the joint between case and cover can be turned and bored very accurately, and the joint is readily sealed against high pressure leakage with circular "O-ring" packing. The diaphragm and one diffuser wall are affixed to the end cover by a system of fitted studs, so that the entire assembly may be removed by simply unbolting the end

FIG. 11. Experimental compressor on test.



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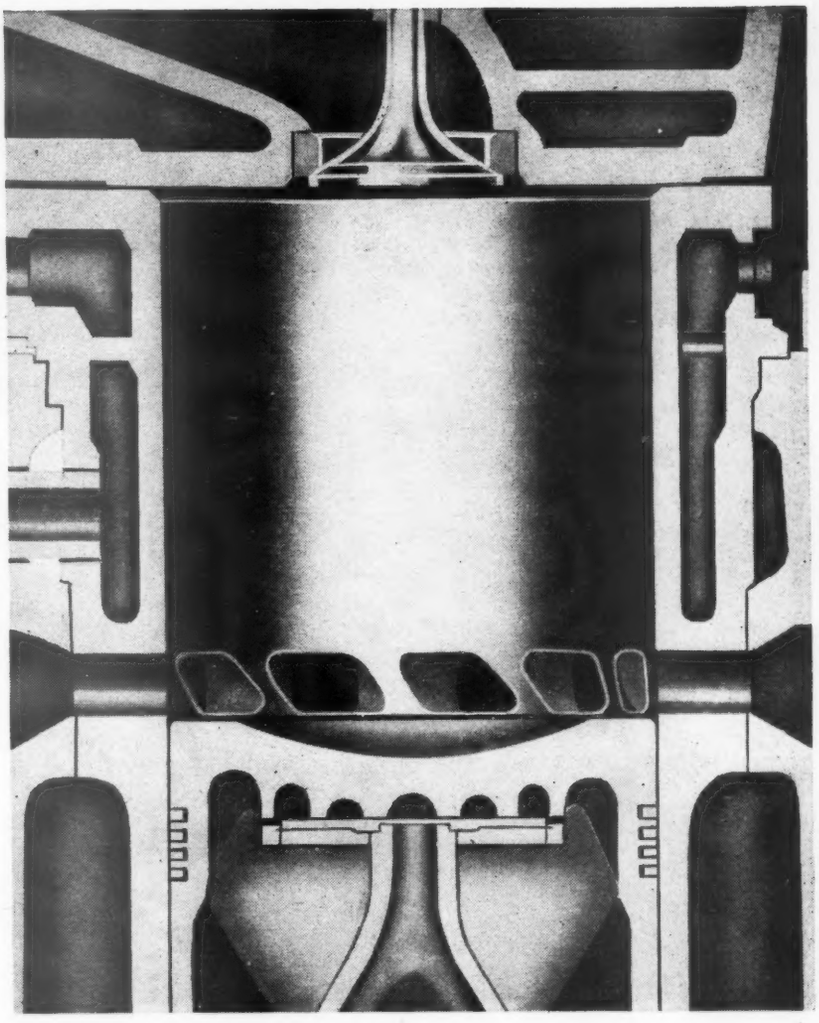
Biggest News in Gas-Engine Compressors



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Complete removal of exhaust gas . . . more thorough charging with gas and air . . . positive timing for optimum combustion . . . effective supercharging . . . low operating temperature preventing carbonization . . . uniform cylinder temperature resulting in equal wall stress eliminating harmful stresses.

Many Uses . . . Many Sizes

While designed primarily as a pipeline gas-engine compressor, the UTC-16 is suitable for many other services, including: pressure maintenance on oil wells . . . in natural gasoline plants . . . in oil refineries, for solvent extraction, vapor recovery, recycling and stabilization of gases . . . in petrochemical processing of products made from natural gas under pressure . . . in many refrigeration applications.

The Uniflo UTC-16 is built in sizes ranging from 800 to 2000 hp. For further proof that *there's more worth in Worthington*, contact our nearest Branch Office, or write the Worthington Pump and Machinery Corporation, Engine Division, Buffalo, N. Y.

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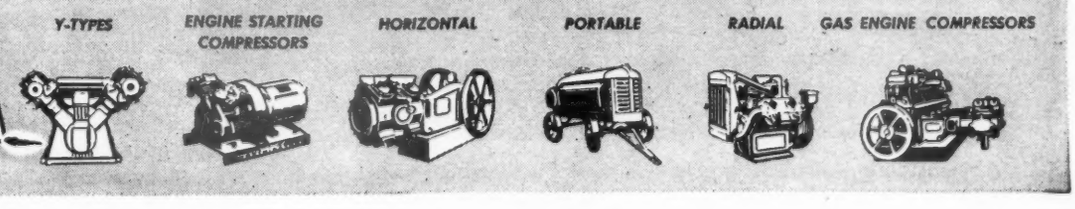

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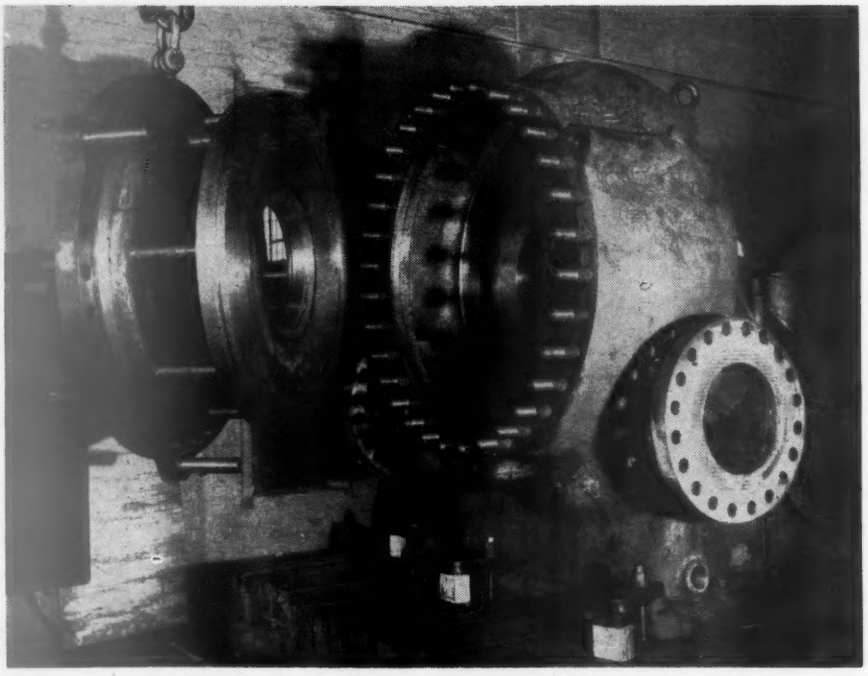


FIG. 12. Removing end cover assembly.

cover. Fig. 12 shows the end cover assembly being removed from the machine.

The impeller, shaft, bearings, and shaft seal are all housed in a barrel structure, and the entire assembly may be removed from the case in one piece. Fig. 13 shows the rotor and barrel assembly removed from the case. This construction allows easy assembly of the close-tolerance rotor parts on the bench, and, assuming a spare barrel assembly is kept on hand, permits a rapid change with minimum down time in the event of seal or bearing trouble while the compressor is in operation on the pipe line. The end of the barrel that houses the thrust bearing and outer journal bearing is split, as shown in Fig. 14, to allow inspection of these parts without removing the barrel from the case. If it is desired to inspect the shaft seal and inner bearing without removing the barrel from the case, this may be done by removing the impeller from the

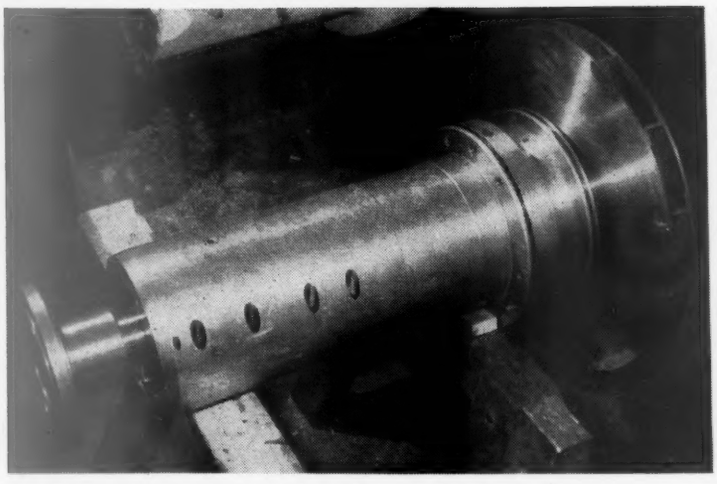


FIG. 13. Rotor and barrel assembly.

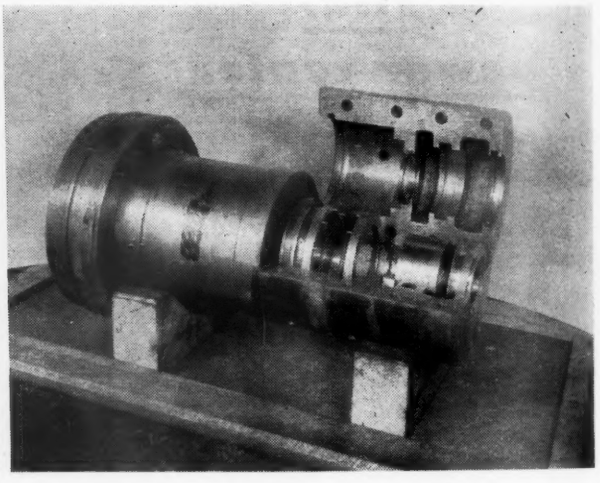


FIG. 14. Thrust bearing and outer journal bearing.

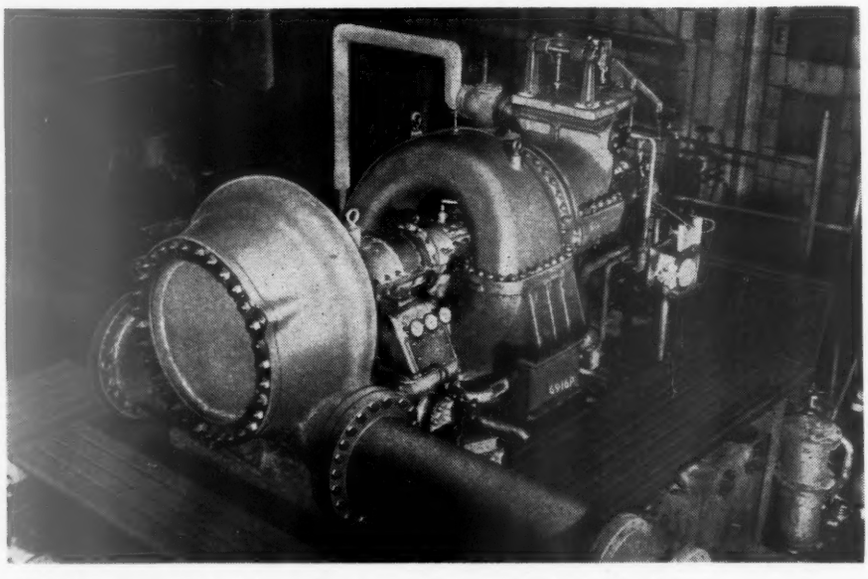


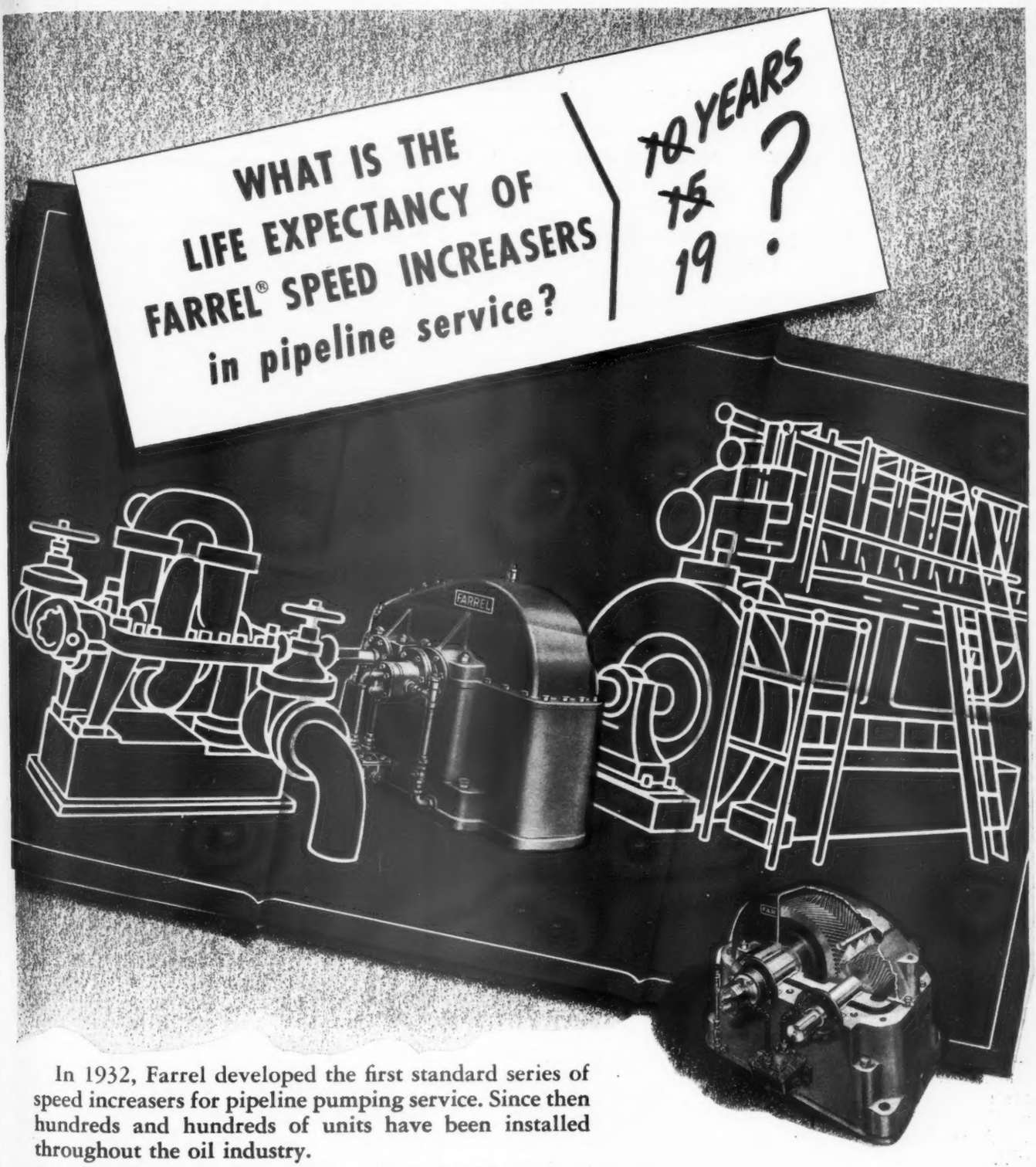
FIG. 15. Steam-turbine-driven pipe line compressor undergoing test.

shaft in the case. With the impeller off, the seal is readily accessible.

Fig. 15 shows the first steam-turbine-driven pipe line compressor in the country undergoing test at De Laval. This unit is one of three designed and built for the Transcontinental Gas Pipe Line Corporation, which are installed in Transcontinental's station at Tylertown, Mississippi. The design point rating of this turbo-compressor is 4880 bhp at 4500 rpm; the three machines, operating in series, will pump 603,000,000 std. cu ft per day of gas through a pressure ratio of 1.585. It should be mentioned that the photograph of Fig. 15 shows the machine "undressed" for test purposes. When installed it will be completely lagged, so that the only protuberances will be the gas lines to the compressor and the turbine throttle valve. ***

WHAT IS THE LIFE EXPECTANCY OF FARREL® SPEED INCREASERS in pipeline service?

~~10~~ ~~15~~ 19 YEARS ?



In 1932, Farrel developed the first standard series of speed increasers for pipeline pumping service. Since then hundreds and hundreds of units have been installed throughout the oil industry.

All of the original speed increasers built in 1932, as well as those installed since, are still in operation, performing as well as when they were first placed in service. This indicates that the life expectancy—or *average* service life—of a Farrel speed increaser is considerably over nineteen years!

For the reasons why these speed increasers are so long-lived, write for your copy of Bulletin No. 448A. No cost or obligation.

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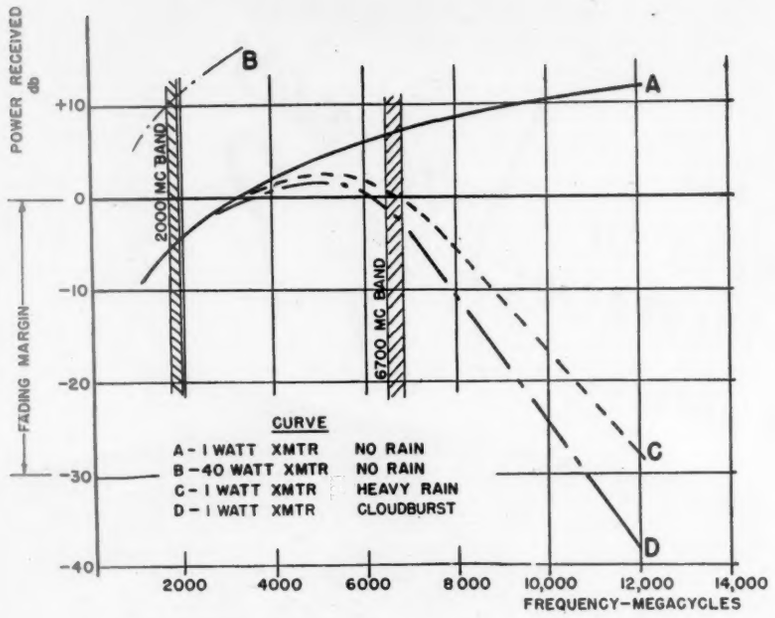


FIG. 1. Effect of weather on microwave circuits.
(Assuming constant transmitter power and antenna size)

Microwave Communications For Pipe Line Use*

Both installation and operating problems—Initial expenditure and cost of maintenance

E. B. DUNN†

THE last century is one that has witnessed the simultaneous development of modern transportation and modern communications. One hundred years ago, the Morse telegraph provided the first electrical communications system and the first dispatching circuits for the nation's early railroads. During the last 50 years we have seen the rapid development of telephone facilities, and today most pipe lines (as well as most railroads) rely on the telephone for dispatching and general business communications. There is little need to emphasize the need for the most reliable communications for these purposes. Those of you who have operated telephone lines are familiar with the problems of circuit interruption due to weather, storm and man-made accident; and you have some idea of the cost of telephone right-of-way, construction, and annual maintenance.

As a result of all this, pipeliners have long considered the use of radio for their point-to-point communications circuits; radio uses a transmission medium that is essentially immune to failure due to acts of God or man—and which is, best of all, provided rent-free by Mother Nature.

Most pipe lines already use VHF radio for "Mobile" communications from base stations to trucks, repair crews, etc., and occasionally use these frequencies for emergency communications from one fixed point to another. The fact was, however, that prior to the last war, there was not enough space in the usable radio spectrum to accommodate existing vital radio services, and no space at all to be used for replacing land lines in point-to-point service.

Wartime developments in superhigh frequencies for radar, shoran, IFF, etc., changed all this. In a few years, the radio "frontier" was pushed upward from about 150 megacycles to about 30,000 megacycles. These newly available "microwave" frequencies increased the usable radio spectrum by more than 200 times the entire prewar space.

After the war, the Federal Communications Commission allocated the microwave spectrum to various users. The frequencies between 150 and 950 megacycles were given to television, aircraft, mobile, radio altimeters, citizens band, color television, and government services. The space above 950 mc has been reserved for radar, microwave communications, microwave diathermy, television relaying, aircraft navigation, and experimental purposes.

In November, 1949, the Keystone Pipe Line put into commercial operation the first microwave communications system employed for pipe line use. This system employs Pulse Time Modulation equipment manufactured by Federal Telephone and Radio Corporation. The system is about 70 miles in length, and uses 3 terminals and 2 relay repeaters, all of which operate unattended.

The tremendous radio bandwidth available in the microwave spectrum allows one microwave relay system to carry a large number of communications channels. The Bell microwave systems can handle a thousand telephone conversations, or perhaps two television programs. As pipe lines haven't yet figured out a way to use 1000 circuits, the equipment offered for pipe line use is designed to handle from 5 to 24 channels. Once the basic equipment is installed with a few channels, additional circuits can be added very cheaply up to the design limit of the equipment—the cost is about $700 per channel.

The audio quality of microwave circuits is equal to or better than anything ever offered by wire lines. Audio bandwidth may be whatever you desire, but is generally designed for 200 to 3400 cycle telephone service. Channel noise in our equipment is usually 50 decibels below one milliwatt (flat weighting), and is not apparent unless the channel output is amplified. Transmission losses may be completely eliminated; in fact, the Keystone Pipe Line dispatching circuits operate from end to end over the microwave at a slight gain. Crosstalk is almost non-existent.

Competition in the microwave field has made it possible to install a simple microwave system in flat country for about $600 per mile with eight through channels. A four-channel dispatching system through rough country, with drops every 30 miles, and with spare or standby radio equipment would cost about $1200 per mile of pipe line. For estimating purposes,

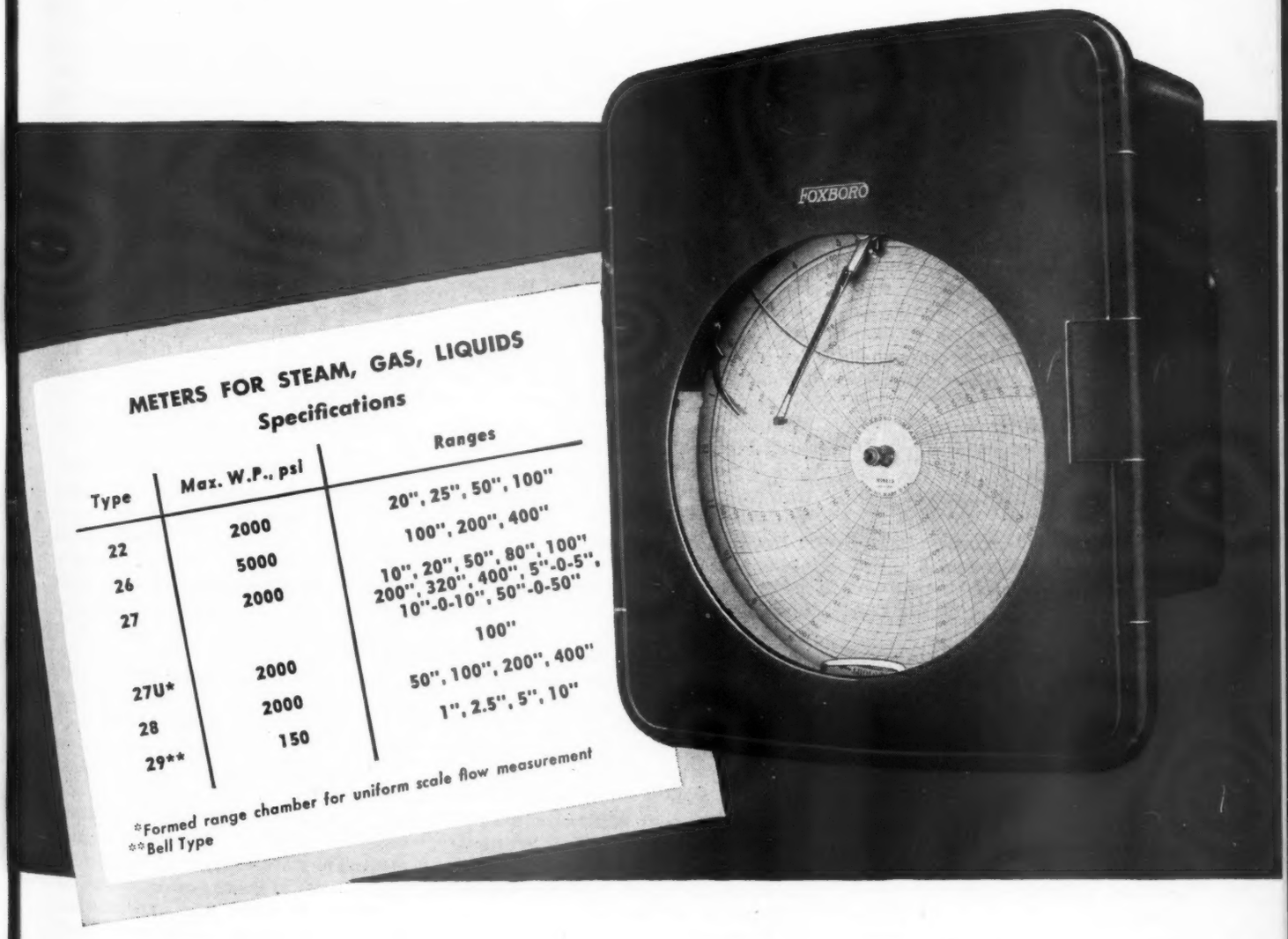
*Presented before Southern Gas Association, Biloxi, Mississippi, April 23-25, 1951.
†Keystone Pipe Line Company.

Higher sustained accuracy, less maintenance than ever before!

Outstanding improvements in every basic detail of differential meter design now afford a new complete line of Foxboro Flow Meters that set an unprecedented standard of dependable accuracy.

In addition to the important features outlined on the opposite page, these new meters retain all the uniquely advantageous features of the previous Foxboro line, including large floats with long travel for added power; and floats located in high pressure chamber to minimize ambient temperature effects. The combined result is practical metering performance that's farther ahead of the field than ever before . . . in maintenance-freedom as well as sustained accuracy.

Check up on all the advantages of the new Foxboro Flow Meters. Available in round or rectangular cases . . . as indicators, recorders, controllers or transmitters . . . with or without integrators. There's a type for every metering problem. Write for New Bulletin 460. **The Foxboro Company, 13010 Neponset Ave., Foxboro, Mass., U.S.A.**



METERS FOR STEAM, GAS, LIQUIDS

Specifications

Type	Max. W.P., psi	Ranges
22	2000	20", 25", 50", 100"
26	5000	100", 200", 400"
27	2000	10", 20", 50", 80", 100", 200", 320", 400", 5"-0-5", 10"-0-10", 50"-0-50"
27U*	2000	100"
28	2000	50", 100", 200", 400"
29**	150	1", 2.5", 5", 10"

*Formed range chamber for uniform scale flow measurement
**Bell Type

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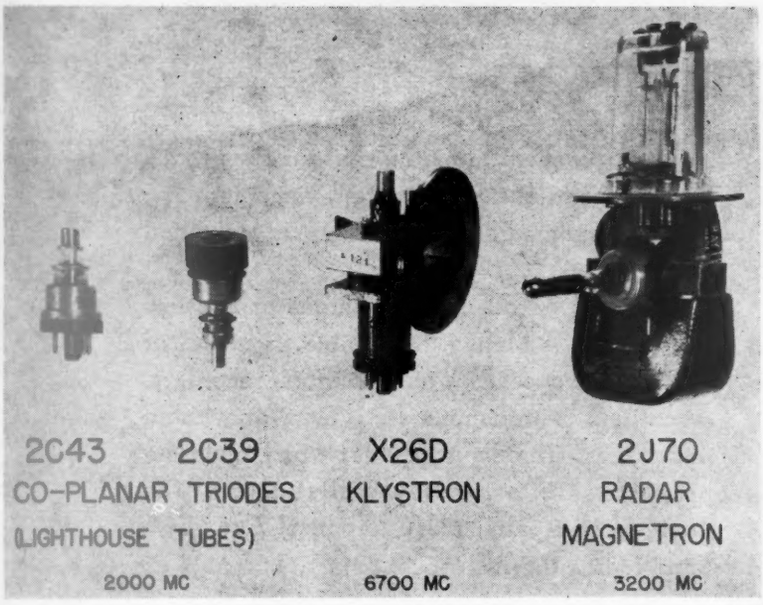
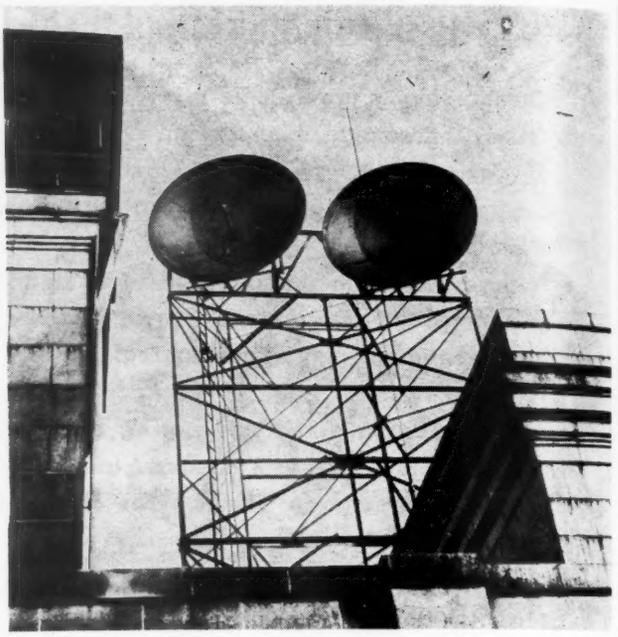


FIG. 2. Output tubes commonly used in microwave equipment.

FIG. 3. Antennas of KPL microwave system mounted on roof of office building in Philadelphia.



a good figure to use is $20,000 per microwave link. Microwave costs, like telephone costs, depend largely on the type of service required and the nature of the terrain, but you will probably find these estimates very attractive.

It is difficult to make a single estimate of annual cost that is an average of all pertinent factors in a field so new; however, based on Keystone's experience with its equipment and based on the feeling that 150 miles in Pennsylvania or 200 miles in flat country is the maximum distance that one man can service, these estimates would be:

Annual Cost of a Microwave System
150 miles in rough terrain
or
200 miles in flat country

Maintenance	
Salary and travel expense of one maintenance man	$ 6,500
Small tubes (annual change)	1,000
Transmitter and power supply tubes (twice yearly)	3,000
Building and tower maintenance, spare parts	1,000
Electric power ($25 per month per location)	2,500
	$14,000
Depreciation	
Radio equipment (10 year life)	$10,000
Buildings and towers (20 year life)	5,000
Taxes	1,000
	$16,000
Total Cost	
Per year	$30,000
Per mile (150 mile system)	200
Per mile (200 mile system)	150

Another products pipe line in the Pennsylvania area reports that its annual cost of leased telephone circuits is about $75 per line mile including circuit rental, equipment rental, and taxes. Based on this figure, you must have need for either two or three leased circuits before you could make an economic justification of a microwave system. This simple economic fact neglects the benefits of the other circuits that are available on microwave at little extra cost. These circuits can be used for pipe line business, for telemetering and remote control, and for the control of mobile radio base stations. In addition, there is a real advantage in microwave reliability and in the fact that a microwave system can be independent of outside maintenance effort.

For those of you who feel that your needs alone do not justify the investment, the possibility is suggested of forming a joint system operated by two or more parallel pipe lines on a cost sharing basis.

The microwave radio spectrum is a loosely defined band of radio frequencies extending from about 1000 mc (wavelength: 30 centimeters) to about 30,000 mc (wavelength: 1 cm). The curves of Fig. 1 show some of the characteristics of these frequencies. As the antennas used increase in effectiveness with increasing frequency, the received signal might ordinarily be expected to increase with increasing frequency, all other factors being held constant. (Curve A). Normal weather conditions however seriously affect the microwave frequencies above 7000 mc (Curves C and D). A 10,000-mc radar can be completely blanked out by a tropical cloudbust; a 30,000-mc radar is limited to a few miles effective range by water vapor absorption. An interesting sidelight is the fact that these highest frequencies are useful in the laboratory for microwave spectroscopy of gases.

From the curves of Fig. 1 you might conclude that the microwave spectrum in the neighborhood of 5000 mc would be the ideal spot for microwave communications, but this band is, of course, reserved for government use. Pipe line communications fall into two bands, 2000 mc and 6700 mc. The increased antenna efficiency of the higher band is partially offset by the higher power of lower band transmitters. (Curve B).

Of the many factors that have contributed to the successful use of microwave frequencies, perhaps the most important has been the development of tubes that could produce a usable amount of radio power at these high frequencies. The ordinary triode has been pushed higher and higher in operating frequency until it has become anything but ordinary in appearance. Because of their shape the two microwave triodes, 2C43 and 2C39 shown in Fig. 2, are commonly known as "lighthouse" tubes. They are used in the range of 100 to 3000 mc, and are commonly employed as output tubes in 2000-mc microwave equipment. They are capable of about four to six watts average power output, or of about 40 watts peak power when used in pulse type equipment. Their cost is $25 and $40 each.

The 6700-mc equipment makes use of the velocity modulated oscillator known as a Klystron. The sample Klystron shown in Fig. 2 is the X-26-C used by Philco. It is rated at

PIPE-LINERS' PUZZLE

What's the smallest coin you can use to cover this system?

TRY IT YOURSELF! You'll find a half-dollar too large. Same with a quarter and a nickel. A dime's too small. But a penny covers it exactly—with the smallest amount of money.

•

Our goal is to be able to cover any and every system as efficiently as a penny covers the one above. Pipe-line progress is going ahead by leaps and bounds. And the Bell System is working right along with the pipe-line industry, keeping pace with its communications needs.

Our business is communications. We have an army of trained technicians with supplies of precision equipment. With over 4500 miles of integrated microwave radio systems already in operation, we have years of experience in their long-distance application. Our networks of cables and radio relay facilities have taught us much about setting up routings — and alternate routings.

Bell System communications are flexible and quickly adjustable to new and improved methods. Our research and development people are always at work. The newest methods . . . the newest equipment . . . and Experience . . . spell Service as offered by Bell System communications.

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Your Bell Telephone Company will be glad to study your communications problems and needs without charge.

PRIVATE-LINE TELEPHONE

TELETYPEWRITER

MOBILE TELEPHONE

METERING CHANNELS

BELL TELEPHONE SYSTEM

one watt average power output, and costs in the neighborhood of $150 to $200.

Radar equipments commonly employ a tube known as a magnetron. The magnetron shown in Fig. 2 is the 2J70 used by the Raytheon in their 3200-mc commercial radar. It is rated at 15 kilowatts peak power, and costs about $180. Other magnetrons exist that are capable of producing as much as 2,000,000 watts peak power. The tremendous power output of these tubes will mean that they may hold the key to the use of the higher microwave frequencies for communications once the technical problems involved in their modulation, cost, and life are solved.

The second technical factor that has been responsible for the success of microwave communications is the use of parabolic reflectors for antennas. Those shown in Fig. 3 are used by the Keystone Pipe Line system and are mounted on the roof of the Philadelphia office building. Reflectors form the microwave energy into a radio beam in the same manner that a flash-

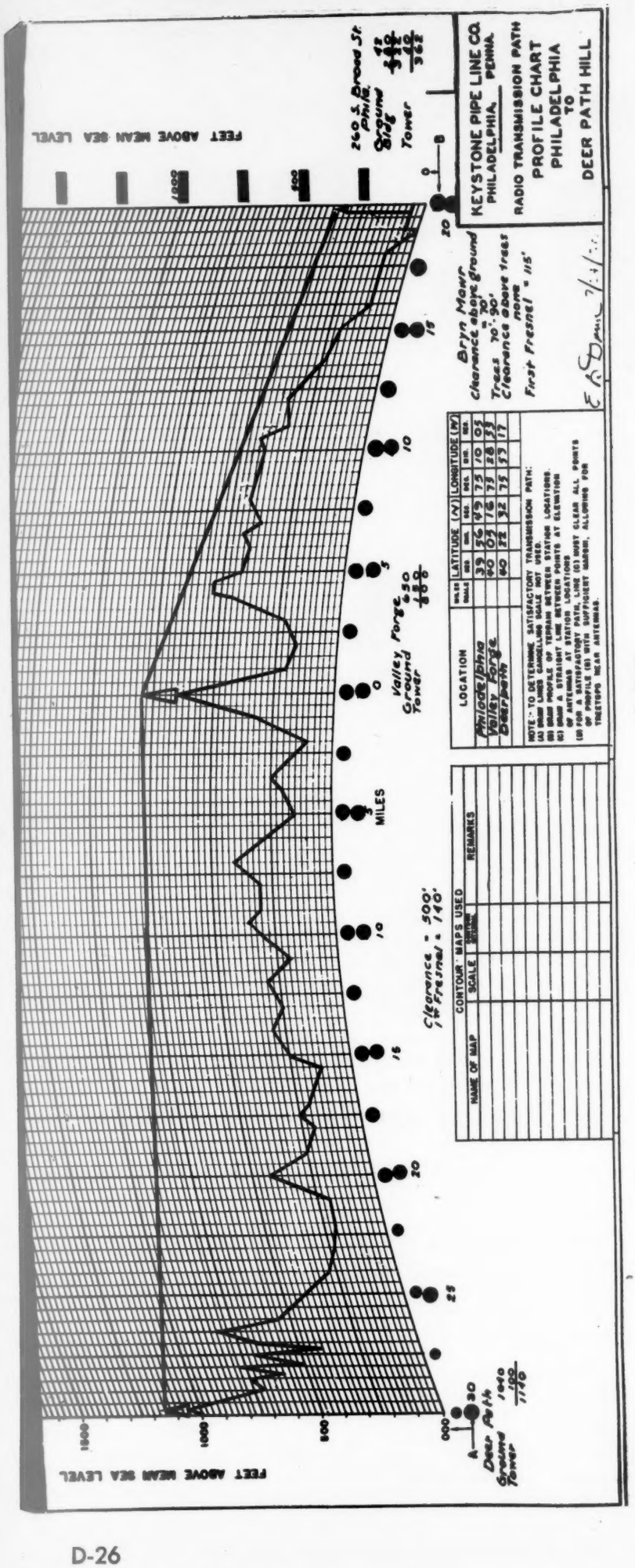
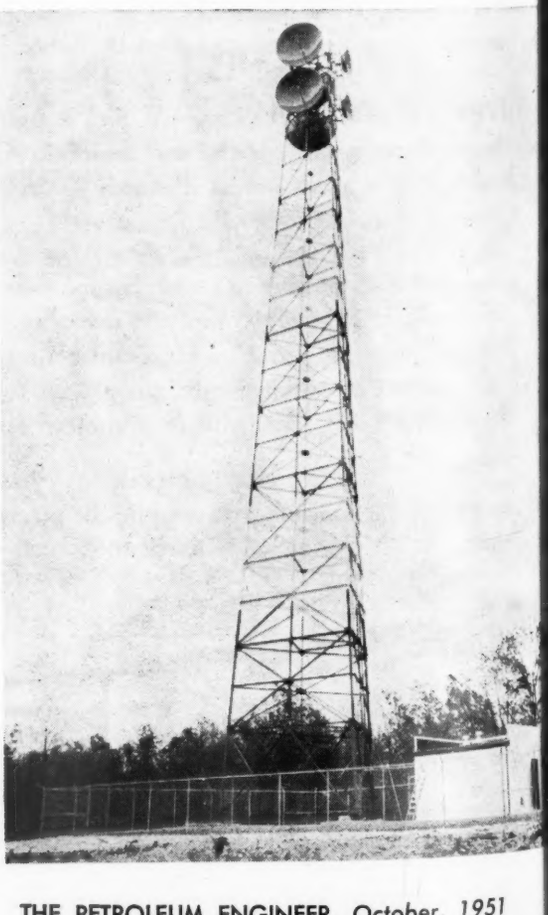


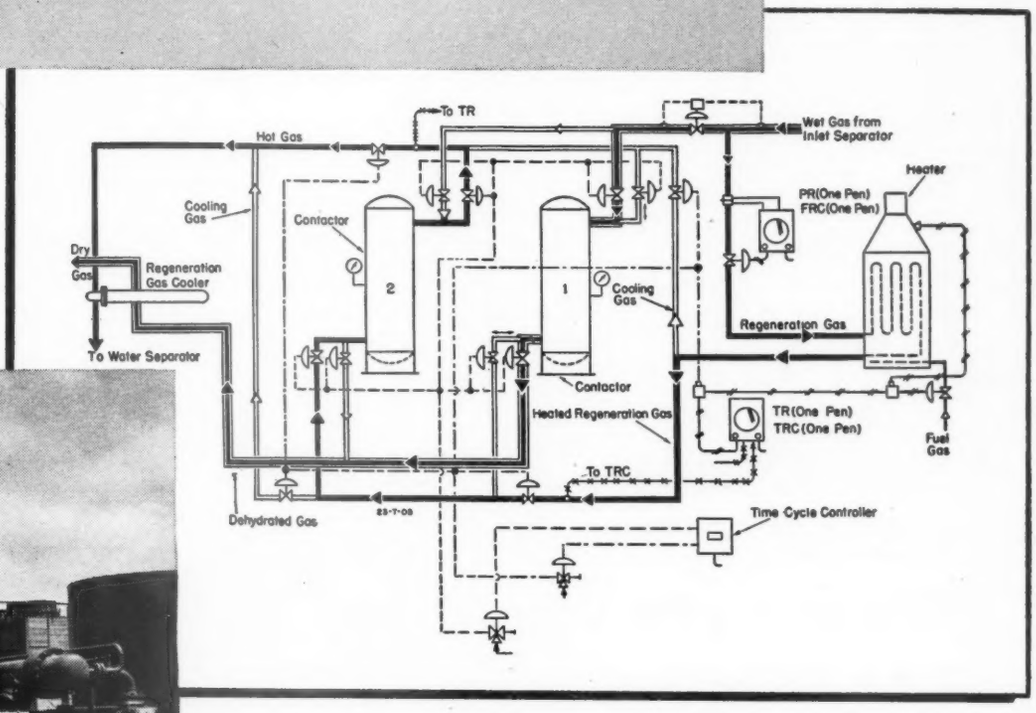
FIG. 4. Profile of 2 hops of KPL microwave system plotted on true earth radius.

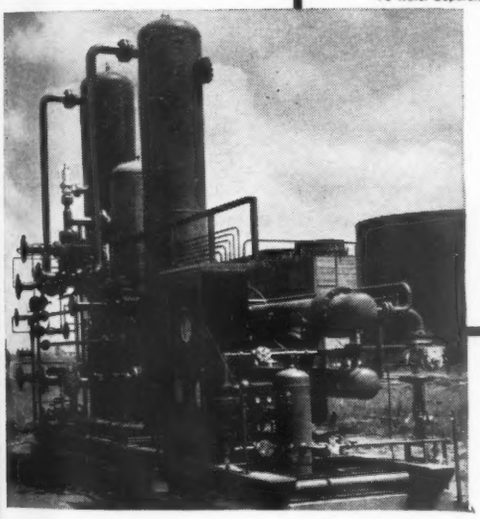
FIG. 5. Unattended microwave relay station at Valley Forge showing 150-ft tower installed by KPL.



COMPLETE CONTROL OF NATURAL GAS DEHYDRATION

... for Transco's new line





Schematic flow diagram of dehydration system and controls. (PR-Brown Pressure Recorder; FRC-Brown Recording Flow Controller; TR-Brown Thermometer Recorder; TRC-Brown Recording Thermometer Controller.)

PUSHING millions of cubic feet of dehydrated natural gas from the Rio Grande Valley to New York City takes some doing! To enable Transcontinental Gas Pipe Line Corporation to meet demands all along the route, Fish Constructors, Inc., have built a series of packaged plants designed to dehydrate the gas to a dew point of 25°F . . . equivalent to 6 pounds of water per million cubic feet of gas at 800 psi.

To assure proper drying, to avoid freezing or the formation of hydrates in the lines, to minimize corrosion, to eliminate water vapors . . . the plants will be *completely automatic and fool-proof.*

The dependability and efficiency of operation of these plants rest on modern instrumentation. Pressure Recorders, Recording Flow Controllers, Diaphragm Motor Valves, Cycle Timers . . . all are integrated into a self-sufficient control system.

Complete details on this installation are available. Write for a reprint of Instrumentation article, "Natural Gas Dehydration." MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4475 Wayne Ave., Philadelphia 44, Pa.

LITERATURE OF INTEREST

Write for your copies of Data Sheets on the new Davis Gas Analyzer System for the detection of combustible vapors in compressor or pumping stations . . . and on telemetering systems for long-range transmission of measurements . . . also for catalog 15-16 on pH and conductivity.

MINNEAPOLIS **Honeywell**

Brown Instruments

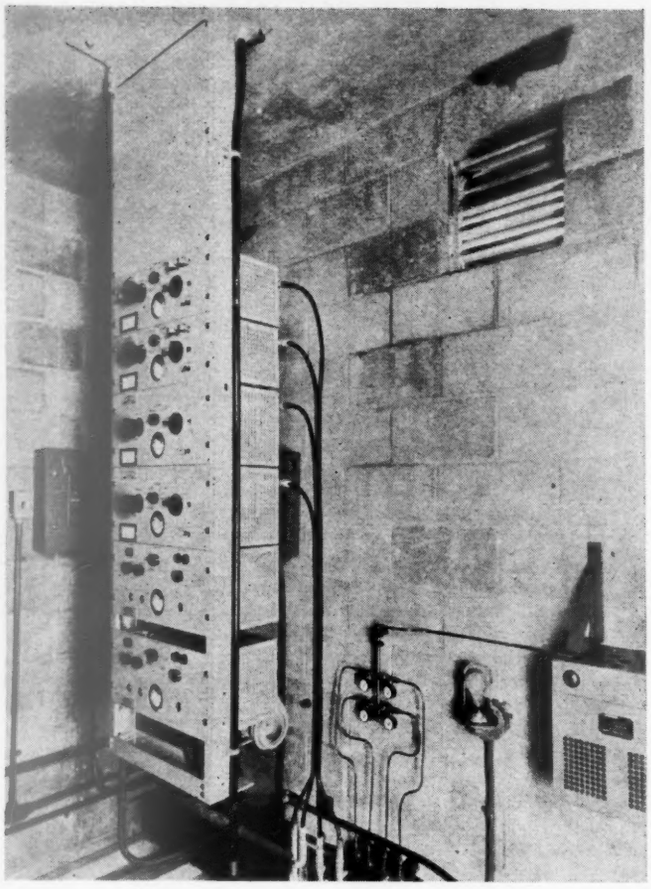


FIG. 6. Microwave relay equipment housed in building at base of Deer Path Hill tower.

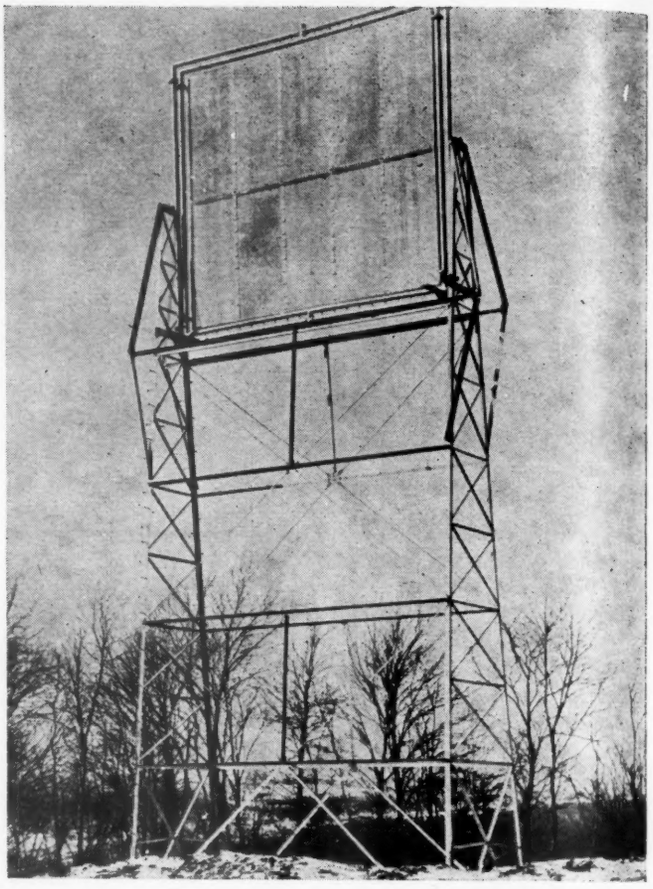


FIG. 8. Large passive reflector used by Pennsylvania Electric Company to "bend" a microwave beam around a mountain near Johnstown, Pennsylvania.

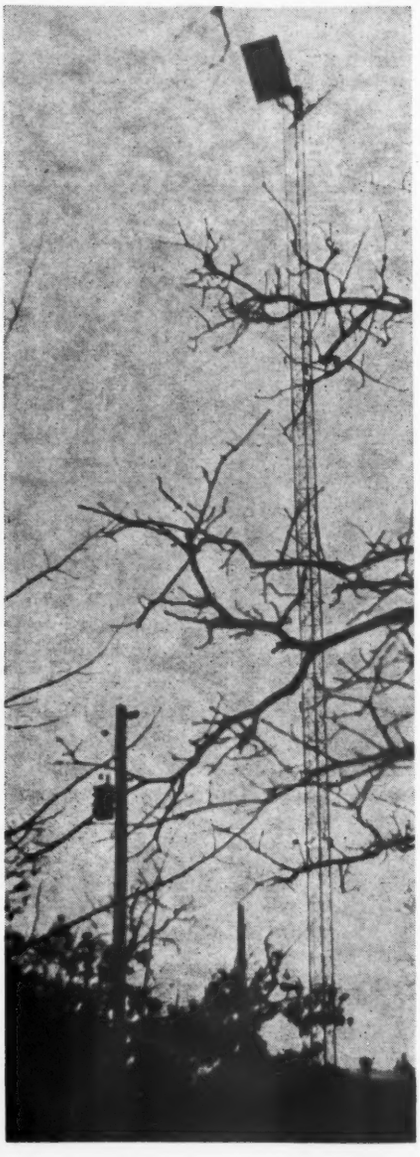


FIG. 7. Right, 280 ft guyed tower equipped with passive reflectors at top. Installed by Humble Pipe Line Company

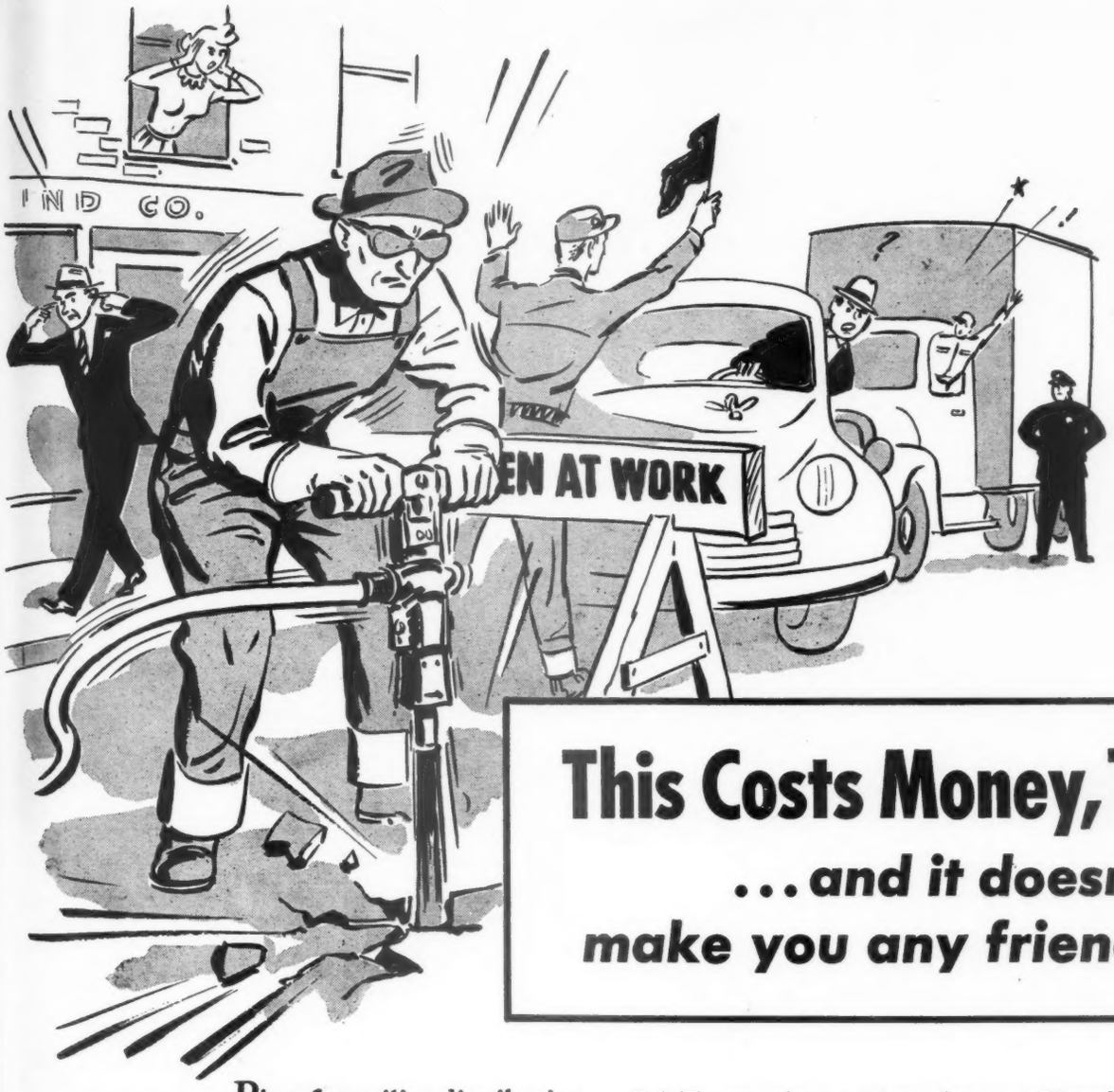
light forms light into a beam. This beam concentrates the radio energy a thousand times until the 40 watts output of the transmitter becomes, in effect, 40 kilowatts. Thus, a tiny tube can provide enough power to overcome space loss, and at the same time, provide a large safety margin, which is held in reserve to combat atmospheric fading and equipment deterioration. Also the use of narrow beams prevents interference with other beams in the same area. Developments since the KPL System was installed allow one antenna to be used for both transmitting and receiving.

As previously indicated, microwaves in many ways resemble light waves more than they resemble ordinary radio. They may be reflected and refracted; and, although they do penetrate fog, rain, and snow with almost no loss, they will not pass through objects such as buildings, hills or trees. They travel in a straight line, and there is little bending around the earth, and no reflection from the ionospheric layers in upper atmosphere.

For all these reasons, microwave communications are limited to paths over which there is a clear, unobstructed line of sight—from hilltop to hilltop, from tower to tower. The average distance per microwave hop is about 25 miles.

Fig. 4 shows a profile of the two main hops of the Keystone Pipe Line system, which has been plotted from USGS maps and laid out to show the effect of the earth's curvature. The first hop out of Philadelphia barely has grazing clearance about the trees in midpath, but the second hop has nearly 500 ft clearance, a situation that much delights the microwave engineer.

To obtain a line of sight on the first path, it was necessary for Keystone to erect a 150-ft tower at the Valley Forge relay point (Fig. 5). This is a self-supporting tower with the antenna dishes at its top. The radio equipment is housed in the building at the base along with the emergency power supply and tower lighting controls. (Fig.



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Pipe for utility distribution systems deserves even better protection than pipe for pipelines. For one thing, it costs more to dig up when something goes wrong. Also those noisy pavement-breakers and traffic-snarling holes in the streets don't do your public relations any good.

Sure, factory coated pipe costs a shade more, but it pays off by staying in the ground longer and saving on maintenance expense.

P.S. To our pipe coating plants at Girard and Lorain, Ohio, we have added a third at Hammond, Indiana—centered in the steel pipe mill section of the Chicago Switching District. This location enables our customers in the west and southwest to take advantage of the Hill, Hubbell process with faster deliveries. Minimum freight rates include the privilege of coating and wrapping pipe in transit. The new plant has ample storage space.

Hill, Hubbell and Company

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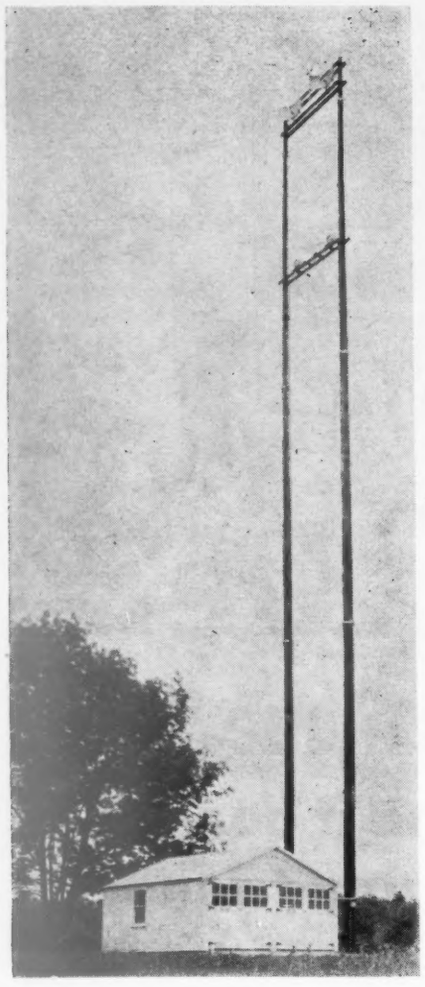
FIG. 9. Guyed H-frame microwave tower 110 ft installed by Raytheon Manufacturing Company.



6). The antennas are fed through coaxial line. This arrangement avoids the dangers, personnel problems, and extra tower cost of having the equipment building at the top of the towers.

The coaxial line, however, represents a substantial cost (about $5 a ft, installed), and the loss in a 150-ft run will sacrifice half of your transmitter power (3 db). As both of these factors increase with frequency, the 6700-mc equipment employs a system of having the antennas mounted horizontally at ground level with a passive mirror reflector at the top of the tower. (Fig. 7—Humble Pipe Line-Philco installation.) This scheme is useful in the range of about 70 to 300 ft in tower height. Below 70 ft, transmission lines are cheaper; above 300 ft, the passive reflectors are too large.

It is interesting to note that large, ground-mounted passive reflectors may be used to "bounce" the beam around corners to avoid obstructions such as nearby hills and buildings. Fig. 8 shows such a passive reflector used on a Westinghouse installation for Pennsylvania Electric Company.

There is some controversy regarding the merits of self-supporting and guyed towers. Guyed towers do require more land for the tower site, but become increasingly more economic with increasing height. The "break-even" point falls somewhere around 75 ft depending on land cost.

A form of tower construction that may become increasingly popular as steel becomes scarce is the "H-frame" structure made of wooden poles. Fig. 9 shows a 110-ft, multiple guyed, H-frame installed by Raytheon on their experimental link from New York to Boston.

Service on the Keystone microwave system is completely unaffected by storm, ice, rain, fog, snow, static, or magnetic storm. When the East Coast "hurricane" hit us in late November, 1950, the microwave system alone rode through the storm without trouble. Our wire lines have been out of service for a week or two at a time following a Pennsylvania ice storm, but the microwave has gone through ice storms without faltering.

The one weather effect that prevents perfection is the phenomenon known as atmospheric fading, which is experienced during the summer and early autumn months. This fading is a result of beam bending, which, in turn, is caused by "stratification" of the moisture vapor content of the air immediately above the ground. This might be the result of a weather front that moves warm, dry air in over moist air to produce a gradual fade (Fig. 10, curve A) resulting from down-bending of the beam. This same phenomenon causes unusually long distance reception of television, FM, mobile radio, and radar, as it often

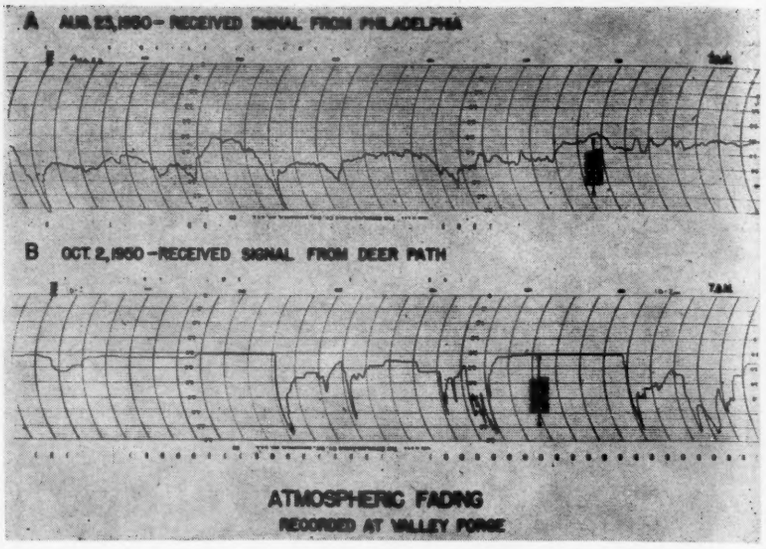

A AUG. 23, 1950 – RECEIVED SIGNAL FROM PHILADELPHIA
B OCT. 2, 1950 – RECEIVED SIGNAL FROM DEER PATH
7 A.M.
ATMOSPHERIC FADING
RECORDED AT VALLEY FORGE

FIG. 10. Recordings of received signal strength at Valley Forge relay of KPL microwave system showing atmospheric fading experienced on two occasions in 1950.

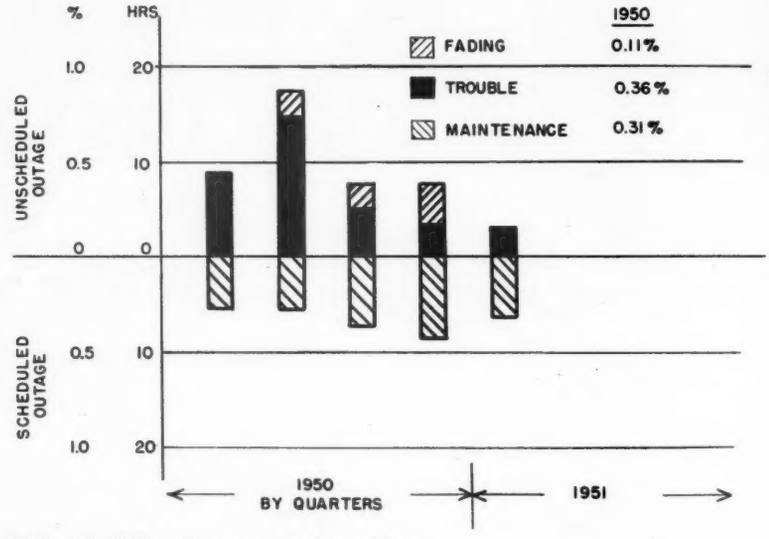
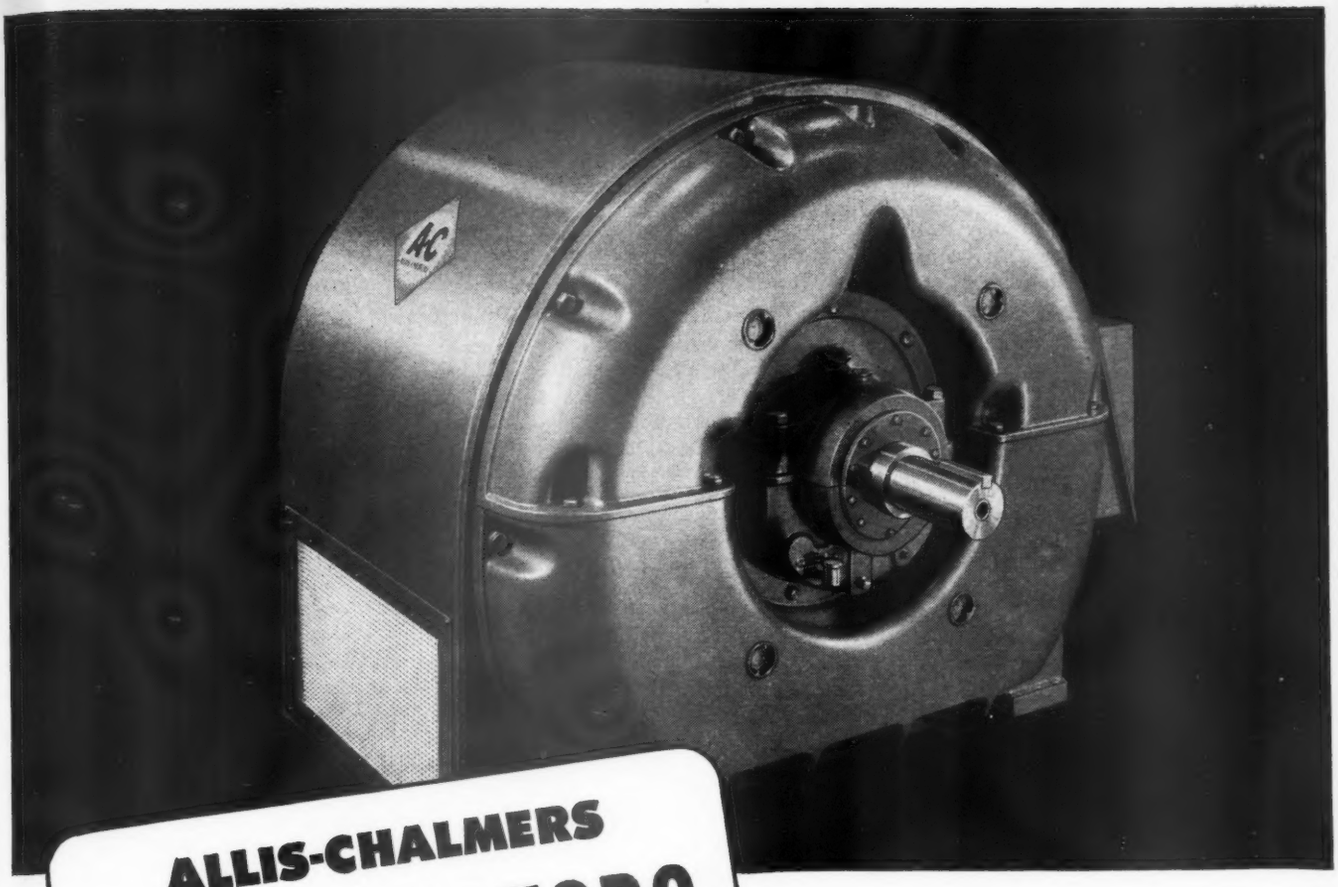


FIG. 11. KPL microwave outage time.



ALLIS-CHALMERS LARGE MOTORS ...Combine Protection & Accessibility

MAINTENANCE COSTS are dealt a double blow by this new line of Allis-Chalmers squirrel-cage induction motors. First, its protective design features minimize the need for maintenance operations. Then, its planned accessibility cuts the cost of doing the maintenance work.

How Maintenance is Reduced

In these motors, protection begins with drip-proof construction. But it does not end there. Air discharge openings in the stator yoke are given the added protection of removable louvered panels. Air intakes in the rigid cast iron end shields are located so as to prevent injury to the windings by mishandled tools or other objects. Capsule-type bearing housings protect the bearings and oil supply when the windings are being cleaned. The capsules can remain sealed against abrasive dirt throughout the cleaning operation.

How Costs Are Cut

This added protection has been achieved without sacrificing accessibility. One man can perform all routine maintenance operations. To check the air gap he simply removes a few screw-type plugs from the bearing end shields.

For cleaning, he removes the upper halves of the end shields and reaches right inside the motor with his vacuum cleaner or air hose. And there is plenty of room to reach up back of the stator core through the air discharge openings in the sides of the yoke.

Wide Range of Sizes

These modern-design drip-proof (or splash-proof) cage motors are built in sizes from 60 hp at 300 rpm to 2000 hp at 1800 rpm. Ask your Allis-Chalmers representative to show you the details of this exceptional new motor, or write Allis-Chalmers, Milwaukee 1, Wisconsin, for bulletin 05B7542.

A-3409

ALLIS-CHALMERS

causes the beam to follow the curvature of the earth. The second type of fade (Fig. 10, curve B) is a result of the opposite conditions, dry air under moist air. This usually occurs on a clear, still night following a humid day when the earth's heat is rapidly lost by radiation, and the moisture vapor is absorbed out of the lower atmosphere by the cool earth to form heavy dew or patches of ground fog. The resulting up-bending of the beam cuts off the signal suddenly and completely.

As the typical radio engineer has very little influence with the "Powers Above," there is nothing he can do about atmospheric fading. He can build a large margin of safety into the equipment, perhaps 30 db, or 1000 times the power normally needed, and this will reduce the fading outage time to something on the order of 0.05 per cent, or about 5 hrs per year per hop according to Keystone experience. Shorter hops and higher towers will help, but these are not usually economical.

The one saving factor is that atmospheric fading usually occurs in the small hours of the night, from 11 p.m. until 4 a.m. This is hard on the maintenance man's sleep, but it is a time when circuits are lightly loaded, and when long distance calls go through with little delay.

All factors that affect the performance of the Keystone microwave have been combined in the outage time record shown in Fig. 11. The atmospheric fading outage totaled 9.6 hr for the year of 1950, and all trouble outage added up to 31.8 hr for the year. This was largely due to tube failure, more than 50 per cent being due to failure of the 2C43 transmitter tubes. The large outage time in the second quarter represents our difficulties with the first 2C43's of postwar manufacture. During this period the average life on these tubes was only two months. Experience has enabled us to detect failures in advance, however, and the average life has recently been raised to about 5 or 6 months by the simple expedient of raising the filament voltage slightly.

The Keystone system has no spare equipment, and the majority of KPL's trouble outage could have been eliminated by standby RF equipment. Likewise, standby equipment would have prevented the scheduled outage time required for all tube changes and maintenance. In a long microwave system the cumulative effect of maintenance outage would justify standby.

The Federal PTM multiplex equipment has been most reliable. Since December, 1949, Keystone has had no multiplex trouble that caused a loss of all circuits, and only two isolated cases of tube failure in an individual channel.

At present it is Keystone's custom to make a weekly check of each unattended repeater, but this could easily be extended to two-week intervals, and perhaps even to monthly intervals. The equipment is stable in RF frequency and in multiplex operation. Maintenance is greatly facilitated by using the oscilloscope to make visual checks of all circuits. Trouble outage time has largely been the time required to locate the maintenance man and get him to the source of trouble. It has averaged about two to three hours per outage. Speedy fault location would be greatly facilitated by a system of fault tones or fault alarms, and such a system of fault location would become a must on a longer microwave system that did not have standby RF.

In conclusion, I believe I can speak for our management in saying that the Keystone experiment in microwave has been completely successful, and that its performance has exceeded both our requirements and our expectations. The best evidence of this success is the manner in which microwave has been accepted by natural gas transmission lines to solve their communications problem. * * *

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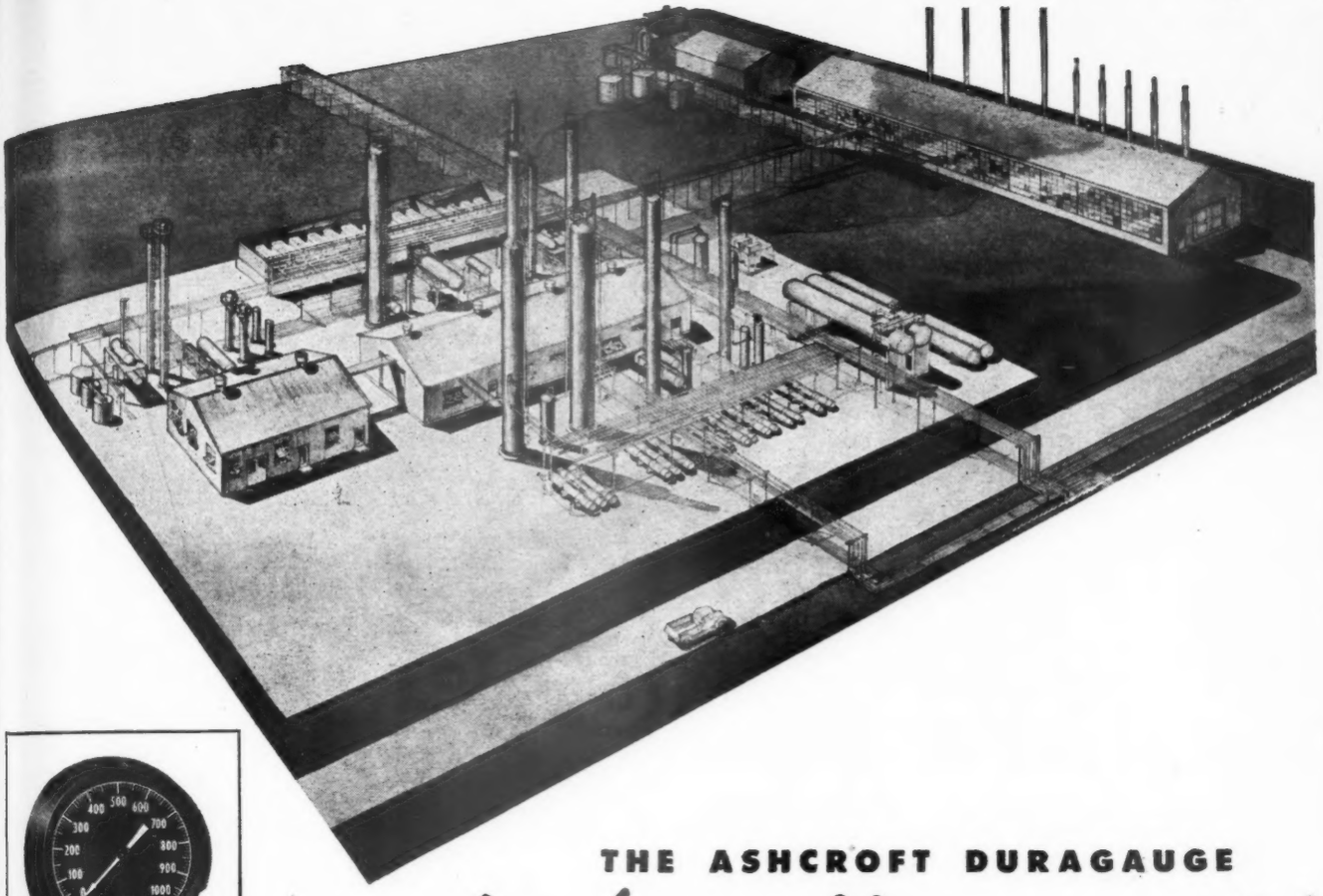

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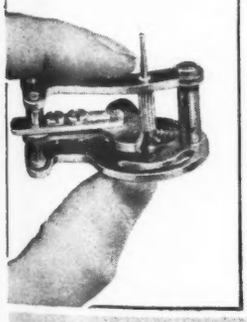

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P 615.91

Aerial view showing work underway on both the east and west banks of the Hudson River.

INSTALLING HUDSON RIVER CROSSING

Laying a pipe line under this navigable stream always presents problems—Here described are methods used by Tennessee Gas Transmission Company

FRANK H. LOVE*

TENNESSEE Gas Transmission Company has completed the crossing of the Hudson River, a sizable undertaking made necessary to extend and tie-in its system with that of its affiliate, Northeastern Gas Transmission Company, now under construction. The latter company will serve natural gas to the New England states.

Crossing of the Hudson was made at Bethlehem, six miles downstream from Albany, New York, and directly on the county lines of Rensselaer and Albany.

*Editor, Oil and Gas Pipelining.

Two 24-in. OD lines having ½-in. wall thickness were installed, only one of which will be used presently, the two lines being tied together by 16-in. tie-over lines and equipped with 16-in. side valves. On the west side of the river 24-in. automatic block valve assemblies have been provided.

The lines were laid 50 ft apart in separate trenches and are in a straight line across the river, neither bowed upstream nor downstream.

EXCLUSIVE

Varying soil formations were encountered on the river's bottom. Near the west bank there was solid rock, on the east side silt, and a combination of the two in the center of the river. To make ditch, the rock and boulders were drilled and shot, then removed with a dipper dredge. A suction dredge made the ditch through the silt, and on the river banks clamshells, draglines, and backhoes were employed.

To comply with regulations of the U. S. Corps of Engineers, the lines had to be laid at a minus 40 ft elevation, that

Safe Operation of Compressor Stations*

Knowing the station equipment and its functions, what to do and what not to do when an emergency arises, are basic factors in safety

E. A. KOENIG†

THE assignment of the subject, "Safe Operation of Compressor Stations," appears to be most appropriate and, certainly, it is an important subject. To give a good, clear-cut paper of interest in a brief period of time, without getting into other overlapping and important points that can govern safe operation, however, is not as simple as it may seem.

If we assume that the design of the station is complete and that all the necessary equipment for the efficient and safe operation of the station is available, then the job becomes one of planned preventive maintenance, planned good housekeeping, and proper operation of machinery. So it means that one should know, in detail, the station piping, wiring, machinery, etc.; how it functions to the last minute operation; what to do when something happens; gas and its behavior; and, above all, what not to do.

We know, of course, that in most cases gas is lighter than air, about 0.6 gravity with respect to air. We know, too, that if you keep it confined and away from air, which contains oxygen, fire or explosion cannot exist. Yet, we have had occasional fires and explosions. Possible leakage can be piped to a safe distance from a station, and then released to the air. Care should be exercised to keep such leakage to a minimum, as the leakage not only costs money, (as shown in Exhibit A) but is ever a potential hazard. This leakage must not be mixed with air until it is at a safe distance from the station, and then permitted to escape through the vent outlet. One example is the compressor packing leakage from the reciprocating compressors, another is the gas blowdowns from these compressors when the unit is stopped for repairs.

Know What to Do

Know what to do when something happens. Let's assume we have a centrifugal compressor station, and that we are experiencing a power failure. What would you do? Our system is designed with an oil reserve tank to feed oil to the seals by gravity when the power fails. This means that the seal oil pump as well as the centrifugal compressor has stopped. A solenoid valve stops the excess oil flow and the overhead tank feeds oil, by gravity, to maintain the seal and to prevent gas leakage.

The auxiliary generator, which starts automatically, supplies lights and enough power to close the suction and discharge valves to each compressor. This is done by pushing a button. After these valves are closed, the compressor may be bled down, releasing all the gas to atmosphere through a piped blowdown. If the power failure is of short duration, the station can be restarted in proper sequence—starting the seal oil pumps and checking all the equipment to see that everything is in order, safe and ready to start.

If the above equipment or the auxiliary fails to function, the remote control devices can be brought into action. This will, by turning one plug valve, close the station suction and discharge, blow down all the gas in the station piping and, also, in the machinery. This happens in the proper sequence and in an elapsed period of time of from 3 to 8 minutes from the time the remote controls are started to operate.

This system has further advantages. Should an accidental fire occur, the gas in the confines of the station is blown to atmosphere and the fire can be brought under control in a short time.

Then, too, the gas can bypass the station. Another step possible, should this become necessary, is to close the head gate valves on either side of the station by remote operating devices. This, of course, would block pipe line flows and is to be a last resort. The same sort of a remote control system, and head gate operators, exists on all our stations, centrifugal and reciprocating.

To know your station piping, wiring and the machinery means that you understand all functions that everything must do. Then if unusual pressures, temperatures, or noises occur, it is a warning that something must be done to correct a condition. That is important, and in most cases just a little attention in the way of minor adjustments will not only save money, time, or serious trouble, but keep the job safer. Carelessness in proper attention to a simple warning similar to the reference just given can be the cause of a serious accident.

In past years, occasionally a reciprocating station or units have been started against closed gates. This was because someone checking valves failed to see that everything was ready to start. Today, we have relief valves to take care of such mistakes, should they occur. These relief valves are a safeguard to accidental closures of valves or sudden pressure surges that might occur, such as a station failure or lack of communication to the station affecting the discharge of another station. If the operating personnel is alert and makes routine checks, however, this condition could be caught in time to slow down, or come off the line if necessary, before any relief valve would have to function. Nevertheless, relief valves are there just in case something goes wrong.

Know What Not to Do

Know what *not* to do. Sometimes a station has been badly overloaded the

EXHIBIT A. Stop leaks.
Values per month.

		Air		Steam		Water		Gas		Gas		Gas	
Size of opening in.	Area per sq in.	Number cu ft wasted per month, 100 psi pressure	Total cost of waste at 10c per M cu ft	Number lb wasted per month, 100 psi pressure	Total cost of waste at 60c per 1000 lb	Number gal wasted per month, 30 psi pressure	Total cost of waste at 15.5c per 1000 gal	Number M cu ft wasted per month, 50 psi pressure	Total cost of waste at 27.3c per M cu ft	Number M cu ft wasted per month, 500 psi pressure	Total cost of waste at 27.3c per M cu ft	Number M cu ft wasted per month, 750 psi pressure	Tota cost of waste at 27.3c per M cu ft
3/8	0.11045	9,979,000	$997.92	469,000	$276.00	602,416	$93.37	6,510	$1780	53,980	$14,740	82,600	$22,500
1/4	0.04909	4,449,600	444.96	293,000	121.80	267,750	41.50	2,890	790	24,000	6,550	36,700	10,000
1/8	0.01227	1,114,560	111.46	50,500	30.30	66,976	10.37	720	200	6,000	1,640	9,200	2500
1/16	0.00307	278,640	27.85	12,750	7.65	16,750	2.60	180	50	1,500	410	2,300	630
1/32	0.00077	69,552	6.96	3,175	1.91	4,198	.65	45	13	380	100	580	160

As a new gasket costs about 5 cents, the saving accomplished by a periodical inspection of compressor systems with respect to possible leaks is well worthwhile.

*Presented before the American Gas Association Safety Conference, Kansas City, Missouri, September 17, 1951.

†General superintendent, Texas Eastern Transmission Corporation.

greater part of the time. Governor rods have also been adjusted to open the throttle wider, then when a light load occurred, the engine would run fast enough to trip the overspeed stop, shorting the ignition and stopping the engine. In restarting the engines, the governors were not reset and, of course, the engine continued to trip out on overspeed. In one instance, the operator merely stuffed a rag under the overspeed stop and when the engine ran away got excited and did not know what to do. Fortunately, someone else knew and closed the gas supply to the engine, stopping it in time to prevent a wreck, a serious accident, or even a fire.

Another operator, with 20 years' experience, could not start his station, did not know enough about his electrical equipment to replace even a 110-volt, 15-amp fuse when something was wrong.

Surely, in both of these cases, they were lucky that something serious did not happen. To me, it means also that this equipment was well engineered, designed, and installed or something serious would have happened. Someone, however, had failed miserably to accept his responsibility of duty, to explain functions properly, and to see that they were done in a safe manner.

All equipment must receive scheduled inspections and checking to see that it functions so that regardless of any condition that can arise, it will work, not only to safeguard property and to save money, but human life, suffering, and loss of time to the individual.

Safety Meetings

In the employees' safety meetings and foremen's meetings, let them freely discuss their problems, ask any questions or make any suggestion. Then analyze these problems carefully and see that they get an intelligent answer. As far as I am concerned, there are no foolish questions. Because, when a man asks a question, he asks to be recognized for the need of knowledge or for the need of help on some problem. Give him simple understanding.

At times, supervisors have "jumped down an employee's throat," so to speak, when an employee asked a question. If that has happened, the employee won the round, although he submitted to unnecessary abuse. This has come to pass when the supervisor did not know the answer, was embarrassed, tried to cover up his ignorance, or for selfish, jealous reasons just "got mad" and "bawled the employee out." It would have been simpler, and less painful, if the supervisor had said, "I don't know, but will find out and give you an answer."

Supervisors have given new men a job to do such as digging out a leak for repairs and then left these employees. The employees, being new and lacking in understanding of the conditions, became scared and certainly lost faith in their boss.

In another instance, the air to an engine was turned on to start it while men were working on it making repairs. This has also been done while men were barring the engine over. This, you say, is inexcusable. But it has happened and there was a reason. Joe was not well, was worried, had troubles at home, and just did not have his mind on his business.

If some of these examples fit your accidents, it is merely a coincidence, because most of these examples happened years ago. They were cited to illustrate and emphasize that it is important at all times to think and plan your work and to work safely.

Know Your Station

To think safely means to know what you are doing, to know your station in

Gets FPC Approval

Michigan Gas Utilities Company, Battle Creek, Michigan, has obtained FPC approval to construct 77 miles of pipe line to carry natural gas from Panhandle Eastern Pipe Line to three towns in south central Michigan. The project will cost about $1,500,000 and will have a daily system capacity of about 11,000,000 cu ft.

for SPEED and ECONOMY use . . .

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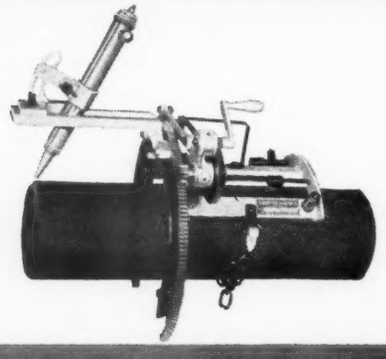
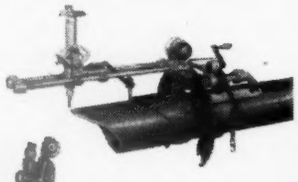
PIPE CUTTING and BEVELING MACHINE



ATTACHMENTS



Shape Cutting Attachment for cutting the various shapes of pipe intersections.

Out-of-Round Attachment is used when pipe is out of round.

speed . . . . . Split horseshoe shaped gear permits machine to slip quickly over pipe. Fast operating snap chain fasteners hold it in place. A complete cut and bevel can be made in a 12 inch pipe in about two minutes.

economy . . . You'll soon save several times the cost of the machine in labor, gas and transportation charges. H&M takes approximately one-half the labor and gas to make the cut as hand cutting and the work is all done in the field.

portability . . Bring this light (24 to 155 pounds) but durable machine to the pipe instead of moving the heavy pipe to the machine. Remember, H&M designs for SPEED and ECONOMY.

Let us arrange a demonstration to show you how H&M will save you money and time. Or write for further details . . .

H&M PIPE BEVELING MACHINE COMPANY

311 E. 3rd St. Tulsa, Okla.

Phone 3-0241

Yes, we're *Always* on the lookout for Pipe Line Progress . . . and here's ANOTHER Midwestern FIRST

Yes, a pipeline OUTER WRAP made from Fiberglas. Several years ago Midwestern and Owens-Corning brought out the first Fiberglas Inner Wrap for reinforcing your coatings. Now, through our combined efforts in seeking "Progress on the Line" we again lead the field in offering this exceptional new product that gives greatly increased corrosion protection at an extremely nominal cost. This amazing new outer wrap is designed to act as an exterior protection for underground pipe line. Composed of asphalted compound with tar additives the material is reinforced in a longitudinal direction by glass fiber mat and strong Fiberglas yarn. The product helps to prevent damage to enamel during lowering-in and back-filling operations and is partcularly valuable in off-setting soil stresses. The high porosity of Fiberglas Outer Wrap reduces holidays by permitting the complete release of trapped gasses and air.

TENSILE STRENGTH—By the use of parallel Fiberglas yarns the tensile strength is greatly increased eliminating breakage.

NON-WICKING — Bitumen-and-glass construction eliminates all moisture wicking action. Will not draw protective fractions of enamel.

EASILY APPLIED—Fiberglas Outer Wrap will apply snugly around any bend.

STORAGE—Fiberglas Outer Wrap will withstand storage temperatures from 0° to 150° F. without deterioration.

BONDING — This Outer Wrap does more than bond . . . it fuses to the enamel becoming a permanent part of the coating.

HIGH MOISTURE RESISTANCE—Moisture absorption is less than one half of one percent.

A PROVEN PRODUCT — Fiberglas Outer Wrap, distributed by the Midwestern Engine and Equipment Company has been accepted by many of the largest companies in both natural gas and crude products transmission lines.

THE BENEFITS OF A FIBERGLAS REINFORCING AND AN OUTSIDE WRAP IN ONE PACKAGE.

MIDWESTERN ENGINE & EQUIPMENT CO., INC.

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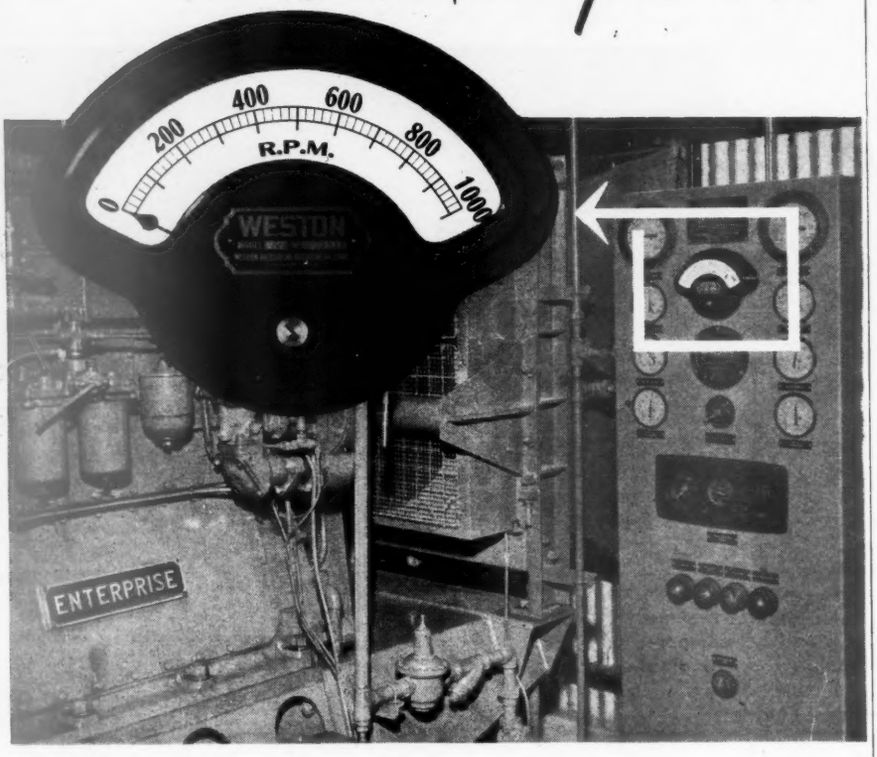
Calhoun 7929

To obtain more information on products advertised see page E-53

On the gauge board at "Antelope"...



WESTON Electrical Tachometer

furnishes dependable, remote RPM indications!

At modern, remote pumping stations . . . where indications must be dependable and instruments trouble-free . . . the WESTON Electrical Tachometer is the logical choice. The indicator is mounted on the remote gauge board, and quickly connected to the generator by a simple wiring connection. Absence of shafting, gearing or other troublesome wearing parts assures long-time dependability and lower costs. Duplicate indications also are possible from the one generator. For complete information on electrical Tachometers, call your nearest WESTON Representative, or write . . . WESTON Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark 5, New Jersey, manufacturers of WESTON and TAGliabue instruments.

WESTON *Instruments*

detail, to understand all the machinery and its functions, to know well enough that temperatures, pressures, unusual noises, or some change means a story of happenings and then to know what to do to restore normal good operation and to do that immediately. Also, to know that when you have done something to affect a station in the way of main line pressure, that the stations on each side of yours should be informed *and also, and not least,* the dispatcher.

Then, "Good Housekeeping," "Good Operation," and "Safety" are so closely related that I accept them to be one and the same thing. Good housekeeping is the essence of safety. Likewise, good operation is the essence of safety. Together, they make safety.

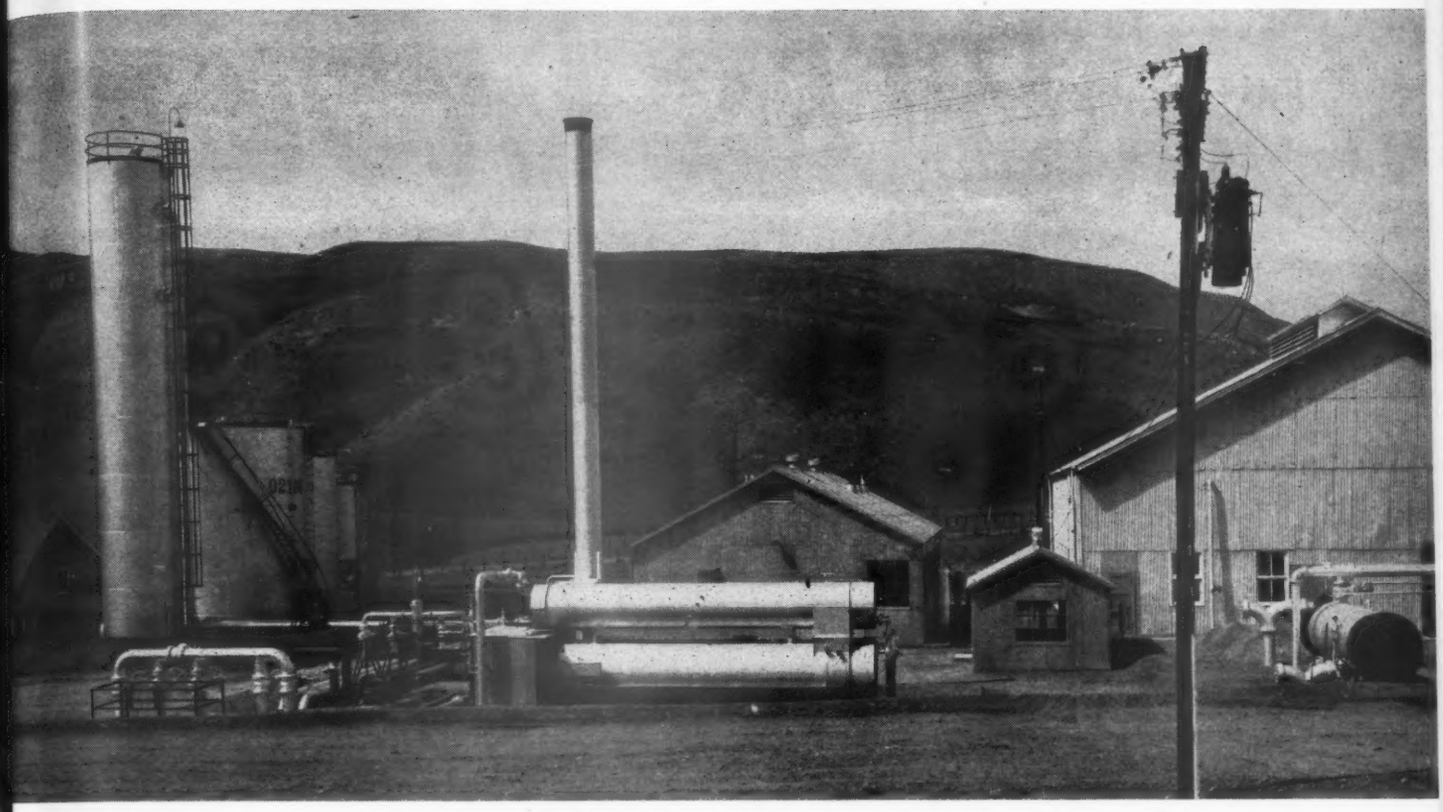
Some of the more common things, and just as important to safety, are slick floors, proper maintenance of explosion-proof fixtures and lights, use of ladders, maintenance of guards, keeping guards in place, floor plates and covers (or any opening over which a man normally walks), proper precautions in freeing equipment of gas during repairs, crankcase explosions, use of goggles when grinding, chipping, or scraping, and many others.

All of these mean that the employee must be properly trained, and to explain to one of them: A little oil spilled and left on the floor will make it slick. It only takes a minute or two to clean it up, and, if left, someone could step on the spot where the oil was spilled and have a serious fall. This has happened. If you have an oil leak, don't use cans, buckets, or rags to soak it up as the leakage occurs. Fix it now, and in so doing you may prevent an accident. Leave it, and sooner or later you will have that accident. A fall can be, and has often been, fatal. You have used a fine slogan in your safety campaigns and programs, "The life you save may be your own."

Today, amidst all of our confusion and most serious problems from Washington to our various states, cities, and even our homes, we are faced with a problem of keeping our heads, senses, and above all, of keeping our minds clear in order to think and work safely. Yet, too often, some problem in life has become so serious in our minds that it distracts from our driving safely and sanely, or from thinking and planning our work safely. This happens, perhaps, in a few minutes at some time during the short course of a day. Because of this, an accident may occur. The person hurt is not always the only one that suffers. In many cases other people become involved through the carelessness of one person.

Let us resolve and promise ourselves not to be that careless person. By being honest and truthful, by giving truthful, honest understanding and cooperation, we can go much farther in the way of making our jobs, homes, communities, and our nation safer and stronger.

* * *



General view of the new Antelope pump station, showing the tall surge tank at the left and the direct fired heater in the foreground.

Diesel Type Engines Operate On Crude Oil

UNION OIL CONSTRUCTS ONE OF MOST MODERN PUMPING STATIONS IN STATE OF CALIFORNIA

RICHARD SNEDDON*

WHEN, after some 43 years of service, the boilers in Union Oil Company's Antelope station on the San Joaquin Valley section of the Junction to Avila main line, were condemned, company engineers and economists seized the opportunity to do some high powered planning that has produced one of the most modern pumping stations in the state of California. Junction is a main line terminal station that receives crude oil pumped from the Coalinga, Kettleman Hills, Lost Hills area, as well as from Bakersfield, Midway Sunset, McKittrick, and other intervening districts. There are two main lines, one carrying light and one heavy oil, running from Junction to Avila, and Antelope is an important booster station south of the Junction terminal.

The plan ultimately proposed after a thorough study of all the elements projected the complete abandonment of the former station with nothing of the original set-up remaining but two 37,500-bbl tanks. It also included total conversion to internal-combustion engine power from the old steam operated system. As a matter of fact, Antelope is today among the first pipe line pumping station anywhere to derive its primary power from the combustion of heavy crude oil in diesel type engines. The heavy line handles crude oil with a gravity of about 16-deg API and after the engines undergo a short warm-up session with diesel oil, it is this heavy oil that supplies all the subsequently required Btu's.

In place of the old boilers and steam pumps there now stand three up-to-the-minute 6-cylinder, 8-in. by 10-in., medium speed, 220 hp at 720 rpm, fuel oil burning, internal-combustion engines, and three positive displacement, single-acting, quintuplex pumps, each rated at 540 bbl an hr at 124 rpm. These engines are completely new, in fact their serial numbers are 1, 2, and 3. The pumps are also of a type that is new to the petroleum industrv. They are connected to the engines by a 5.8 to 1 reduction gear, and in each instance between the gear and the engine is an air clutch.

The pumps are designed to operate at an out-going pressure of 800 psi with an engine bmep of 80 but will be required to run for extended periods at pressures of 250 to 500 psi with a corresponding bmep of 25 to 50. That is the general arrangement but in addition there are many protective devices that guard en-

*Pacific Coast Editor.

EXCLUSIVE

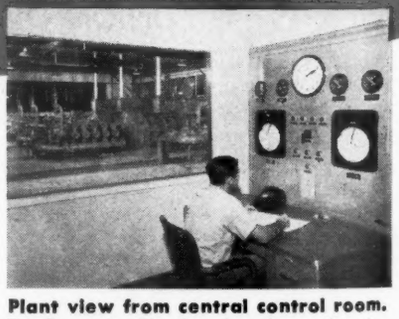
Crude Diet for Diesels

3 dependable Enterprise Diesels supply the power for pumping some 1,000 barrels per hour of 16 gravity crude over 15 miles of 8-inch line.

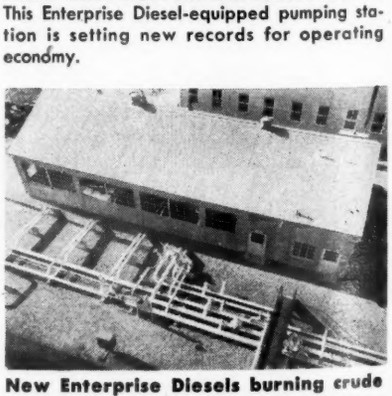
ENTERPRISE POWER FOR A 15 MILE UP-HILL BOOST

An innovation in pipeline pumping power, the *Enterprise* Diesels at Union Oil Company's Antelope Station have set new precedents for operating economy and self-sufficiency. Their ability to take unrefined 16-gravity crude from the pipeline and burn it cleanly and efficiently is the result of exhaustive testing and modifications of basic distillate fuel-burning engine models by the *Enterprise* research and development staff. This work was speeded through close collaboration with Union Oil Company's Research Department, and its contribution of specialized knowledge of fuel and lube oil abilities and properties.

As a result of the highly successful operations at Antelope Station, the pattern has been set for still another pumping plant modernization job at Union's Junction Station, which will be equipped with 6 *Enterprise* DSM-6's—also to operate on crude fuel tapped from the pipeline.



Plant view from central control room. This Enterprise Diesel-equipped pumping station is setting new records for operating economy.

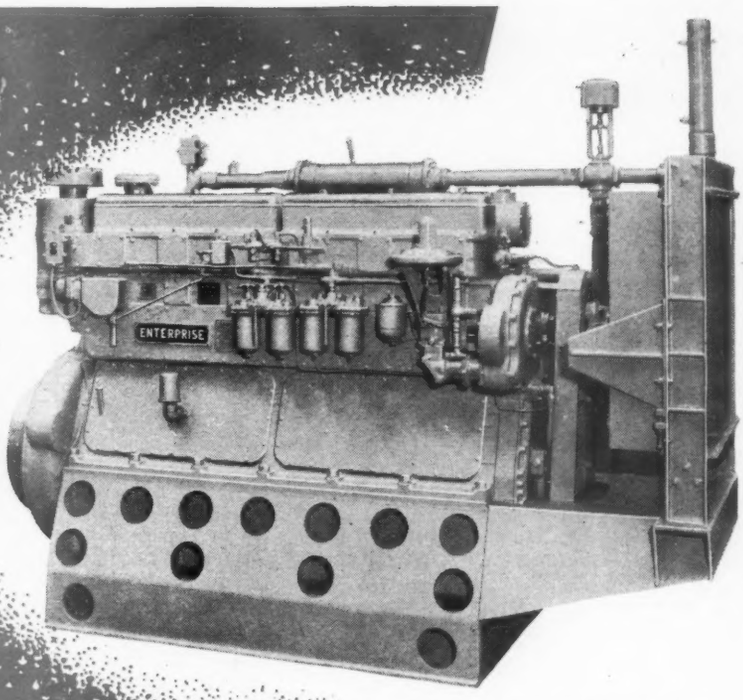


New Enterprise Diesels burning crude oil picked up the load carried for 42 years by a steam plant—with no interruption of operations.

Pays Off

AT UNION OIL COMPANY'S NEWLY MODERNIZED PUMPING STATION NEAR BAKERSFIELD, CALIFORNIA

ENTERPRISE DSM-6 DIESELS BURN HEAVY PIPELINE CRUDE -SAVES 90% in fuel!



Rated 220 HP at 720 RPM, these rugged 6 cylinder Enterprise Diesels run on a diet of unrefined pipeline crude. Despite a viscosity of 800 to 1000 SSU at 122° F., a remarkably high combustion efficiency is maintained —even over extended periods at about half-load.

Replacing the steam pumping equipment which had been in operation for 42 years, modern *Enterprise* heavy fuel engines now drive pumps capable of delivering up to more than 25,000 bbls. per day. These heavy duty, medium speed pumping power units are equipped with heaters, strainers and filters which condition the crude fuel oil for uninterrupted flow through the injection system, and for high and steady combustion efficiency.

Distillate diesel fuel is used for a 15-minute warm up period, and again before shutting down to insure easy starting and clean operation. Fuel costs, as a result, have become a relatively insignificant part of operating overhead, with some 90% less fuel consumed during most of the year than was previously required to operate steam equipment.

These and many other features of *Enterprise* Diesels provide the most satisfactory solution for both new pipeline stations and modernization programs alike.

Write today for full information on *Enterprise* Diesels for pipeline pumping...*the Choice of Power Experts.*

ENTERPRISE ENGINE & MACHINERY CO.
A Subsidiary of General Metals Corporation
18th & Florida Sts., San Francisco 10, California
Offices in Principal Cities

Quintuplex pumps, each with a capacity of 540 bbl at 124 rpm, and the new diesel type internal combustion engines that have been adapted for use with heavy crude oil.

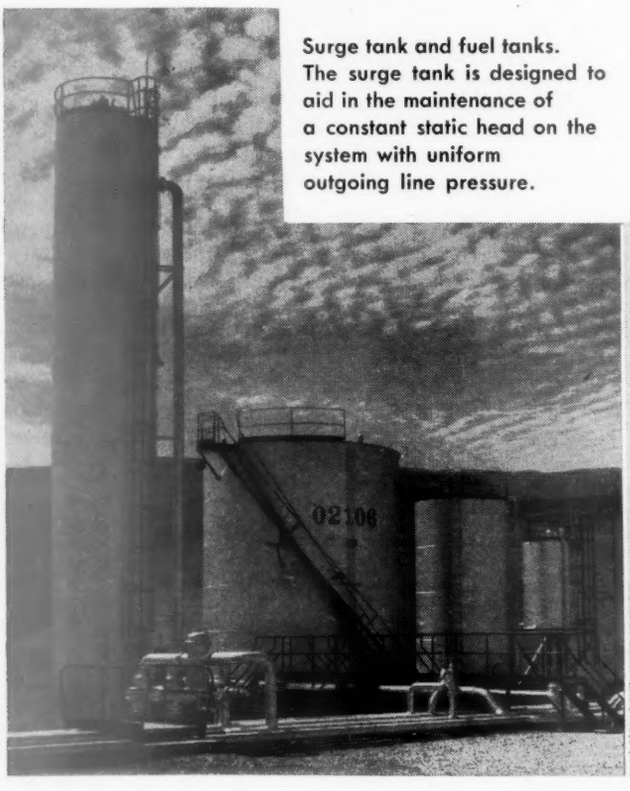
gines, pumps, and operator from a variety of injurious influences and there are a number of interesting installations that render the station very flexible and yet as nearly self-operative as such a unit can be.

One of the two tanks already mentioned now functions as a relief tank and the other has been turned over entirely to storage. Part of the heavy oil coming in through the 8-in. line is in winter time diverted through a direct-fired heater, the feed to which is supplied by a constant speed pump at 600 bbl an hr regardless of the pumping rate through the main line. The pressure drop through the heater is made up by an extra kick from the booster pump.

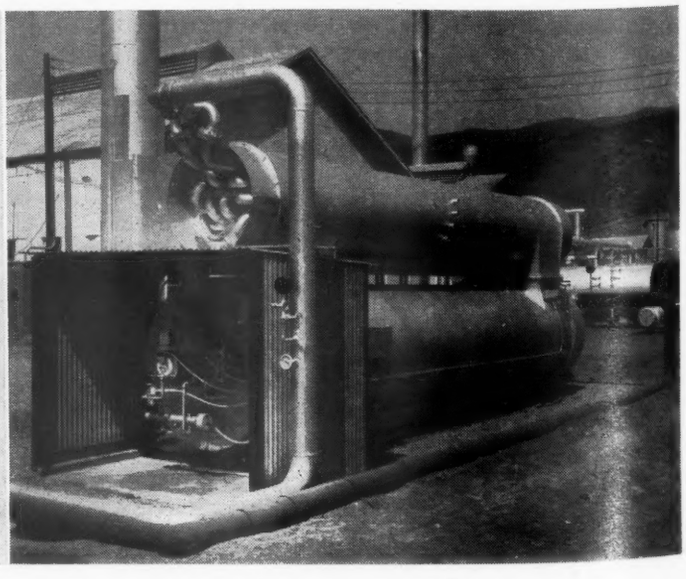
The fuel to the engines is first centrifuged, then purified, filtered, and finally heated in a fuel heater to about 175 F. Thence, with its lowered viscosity, it is again filtered before being injected into the combustion chamber. It might be remarked that after the heater is once lighted it becomes fully automatic. It is equipped with a rotary cup burner that uses crude oil right out of the line. The burner holds the stream from the heater at a constant outgoing temperature and may be adjusted when necessary to maintain a uniform temperature at the pump suction regardless of the temperature or rate of incoming stream.

The rotary burner is electric-eye controlled and automatically shuts off in case of flame failure. A flow meter with an automatic low flow shut-off turns off the burner in case there should be a stoppage of oil flow through the heater. Once it is set, however, for any specific operational condition of temperature and pressure, the heater is both automatic and consistent in its action. Indeed, that is true of the total arrangement. Whenever and wherever mechanical safety can be successfully employed to supplement the care and watchfulness of the operator, it has been included.

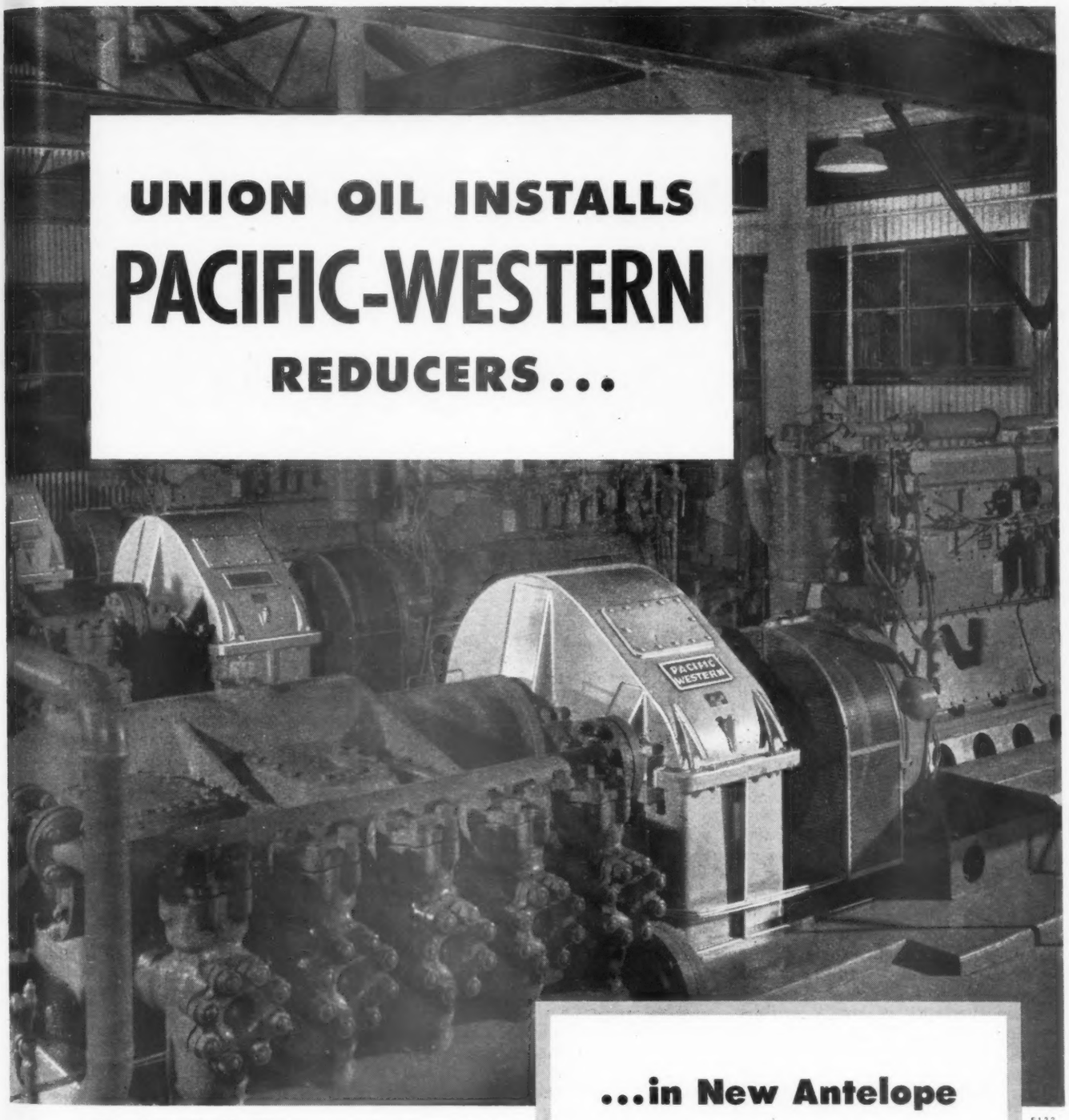
The station pumping rate is controlled by a suction-pressure controller that operates the engine governor through a diaphragm motor. To obtain additional control a surge tank that floats on the



Surge tank and fuel tanks. The surge tank is designed to aid in the maintenance of a constant static head on the system with uniform outgoing line pressure.



The direct-fired heater through which part of the heavy oil stream is directed in winter time. It has a thermal efficiency of 75 per cent and is not needed at all during summer months.



UNION OIL INSTALLS PACIFIC-WESTERN REDUCERS...

5122

The three Pacific-Western speed reducers in the Antelope installation are rated at more than 500 horsepower each, continuous duty, under heavy shock loads. They reduce engine speed of 720 rpm to 124-rpm output for the reciprocating pumps.

...in New Antelope Pumping Station

This crude-oil pumping station, now completely modernized, can serve as a model of efficiency to the industry. In this station, as in many other oil or gas pumping stations throughout the United States, Pacific-Western gear units provide unfaltering service.

WESTERN GEAR WORKS

Manufacturers of **PACIFIC-WESTERN** Gear Products

Pacific Gear & Tool Works

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2600 E. Imperial Highway, Lynwood, Los Angeles County, California
1035 Folsom St., San Francisco 3, Calif.
117 N. Palmer St., Houston, Texas

Representatives • 930 S.E. Oak St., Portland 14, Oregon
Room 211, Chamber of Commerce Bldg., Denver, Colorado
Engineering & Machinery Ltd., 1366 W. Broadway, Vancouver, B.C.

This is part of the auxiliary fire protection installation consisting of a gasoline powered engine and pump.

The instrument panel, showng gages, alarms, and control valves. Slightly different from the original office quarters.

line is used. This operates at a height of 50 to 53 ft, depending on the pre-set of the suction controller, and is fitted with an overflow line at 55 ft above bottom, through which the overflow oil is carried back to the relief tank. This arrangement gives the operator time to open a bypass valve that sends the incoming stream direct to the relief tank. If the level of oil in the surge tank goes above 54 ft 6 in. or below 44 ft 6 in., an alarm signal rings in the pump house.

A thermostatically operated device starts up the fire pumps when the temperature in the building reaches the danger point. This will fog the building and continue to do so, and in case the operator might be overcome or otherwise incapacitated, it automatically issues a telephonic warning. There is, of course, an auxiliary gasoline driven fire pump, manually operated, to take care of emergency occasions. In view of the fact that the station has only one operator and is situated 12 miles from the nearest help, these preventive measures are very much worthwhile.

The Antelope station normally handles about 1000 bbls an hr of heavy oil through the No. 1 line on its way from Junction to Avila. This oil, as already indicated, has a gravity of approximately 16-deg API and a viscosity of 80 to 100 seconds Saybolt Furol at 122 F. Before being used in the engines it is purified and heated as has been described. The engines, however, are started up on diesel oil and when they have reached normal operating temperature are switched over to the heavy fuel. During the summer months, the oil does not need to be heated. A slightly increased line pressure takes care of the situation. This results in a fuel bill that is just about 10 per cent of what it used to be with the old steam equipment, and it might be mentioned in passing that there are more summer months in California than in most other states. The fuel consumption, or its value rather, in the winter months when the heater is being used seems to be about 75 per cent of that for the old steam-operated station, so the overall saving is a pretty substantial item. As this report is written, incidentally, the station has been in operation for some 3000 hrs with excellent results.

The heavy fuel after being conditioned and raised to the proper temperature is picked up by the injection pumps and shot into the nozzles. Before the engines are shut down after each run, they are given a 15 min spell on diesel fuel, just as they are in starting, this time to purge the system of heavy oil and thus make the next starting operation easier.

The lubricating oil is held also at the base temperature, somewhere close to 175 F, by means of a cooler that is part of the engine equipment. It may also be used as a heater when that becomes necessary. In addition, each engine is equipped with full flow lube oil filters that remove suspended gum-forming materials and other undesirables from the oil before it performs its function. Engine speed is controlled by governors with solenoid overspeed trip shut-off. Other auxiliary equipment are oil-bath air cleaners to obviate the entry of dust into the system, and various controls and safety devices. Air for the air-cranking motors, air clutches and pneumatic controls motors, is supplied by dual-drive compressor, electric or gasoline powered. Instrument boards carry the usual assortment of temperature and pressure gages, tachometers, control valves, alarm indicators, and the manual and automatic systems for coordinating engine speed with line pressure.

It is proposed that the same type of equipment be used in the modernization of Junction station, plans for which are now under way. This station, probably the most important in Union Oil Company's San Joaquin Valley pipe line system will have six of the crude oil burning internal-combustion engines described in this article, each driving a positive displacement quintuplex pump through reduction gears. The two stations, indeed, will be very much alike except for size—Junction will be about twice the size of Antelope.

Equipment at Antelope Station

Enterprise DSM 6's.
Sharples oil purifying system.
Cooley fuel heater.
Bendix injection pumps.
Pacific Western reduction gear.
Wilson-Snyder quintuplex pumps.
Honan Crane lube oil filters.
Maxim exhaust spark arrestors and silencers.
Young radiators.
Woodward hydraulic governors.
Air Maze oil-bath air cleaners.
Viking temperature and pressure control contactors.
Automatic Switch Company.
Foxboro air control motors.
Quincy dual drive air compressor.
Gardner Denver air cranking motors.
Fawick Air-Flex clutches.
Columbia Electric Manufacturing Company engine panel board.
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* * *

BIG 310 TRENCHLINER®

WHERE you need an extra range of digging widths and depths for biggest pipeline jobs, check Parsons 310 Trenchliner . . . the industry's largest ladder-type trencher. You get trenches up to 17 feet deep . . . 1½ to 4½ feet wide. Oversize teeth and special side-cutters provide 16 widths, with only 4 standard bucket sizes. Extra-wide boom carriage takes dual booms for trenching 6 feet wide at 11 foot depth.

Maximum digging power is transmitted by roller-chain drive direct to bucket line . . . produces 8 inches to 15½ feet of trench per minute. Selection of 45 digging feeds gives you maximum digging efficiency at any depth, width, and in all types of materials. You never need worry about overload. When heavy-duty, cast-steel digging buckets strike obstruction in trench, band-type safety clutch automatically slips over drum, dissipates any shock load.

Other production-boosting features on the big capacity 310 include: shiftable boom, digs behind either crawler . . . power-shift arc-type conveyor, shifts completely through machine in less than a minute, discharges spoil on either side. All gears, anti-friction bearings and shafts enclosed in unit-type main gear case run in continuous oil bath . . . assure long, trouble-free operation. It will pay you to get full facts. Call your Parsons oil field distributor, or send now for 310 Trenchliner bulletin.

PARSONS COMPANY, Newton, Iowa

Digs

- **17′ DEEP Telescopic boom locks at 14″ depth intervals.**
- **1½′ TO 4½′ WIDE With dual booms, digs 6′ wide.**
- **8″ TO 15½′ PER MINUTE 45 digging feeds . . . 5 reverse.**

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TO: PARSONS COMPANY, Newton, Iowa PE

Send us new 12-page bulletin on 310 Trenchliner

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P38

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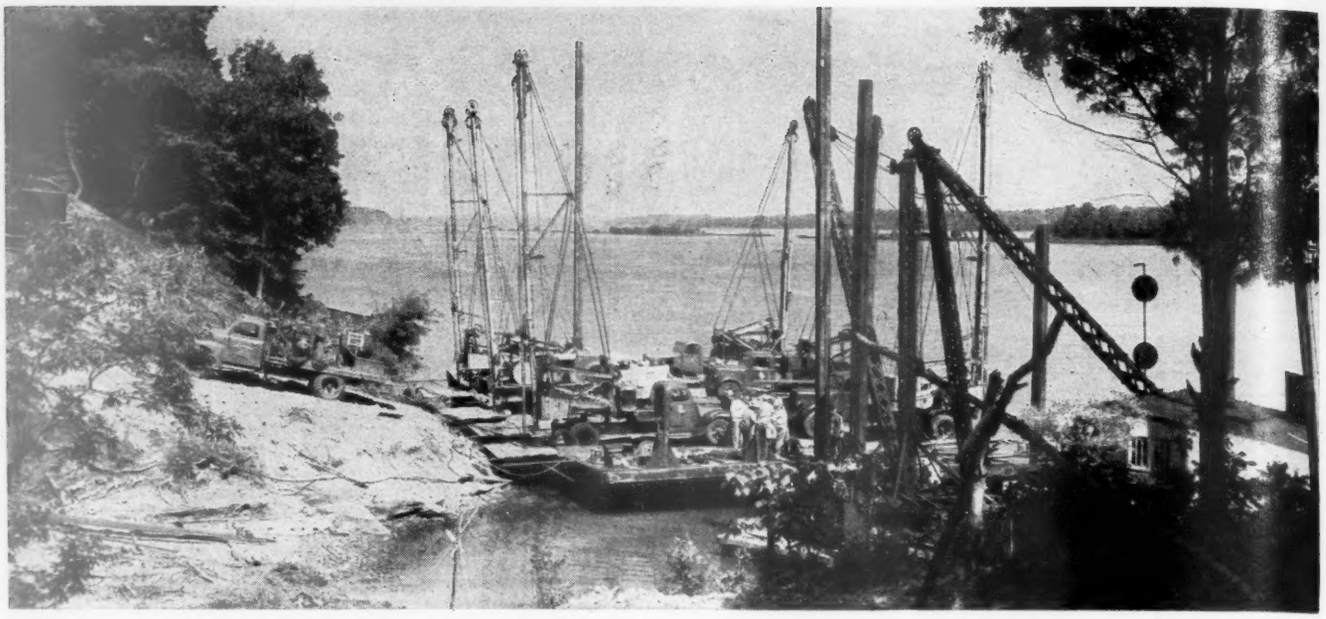


Texas Eastern Transmission Corporation's new 30-in. pipeline crosses the Tennessee River at historic Pride's Landing in the famous Muscle Shoals area in Albama.

Vast Expansion Program Underway

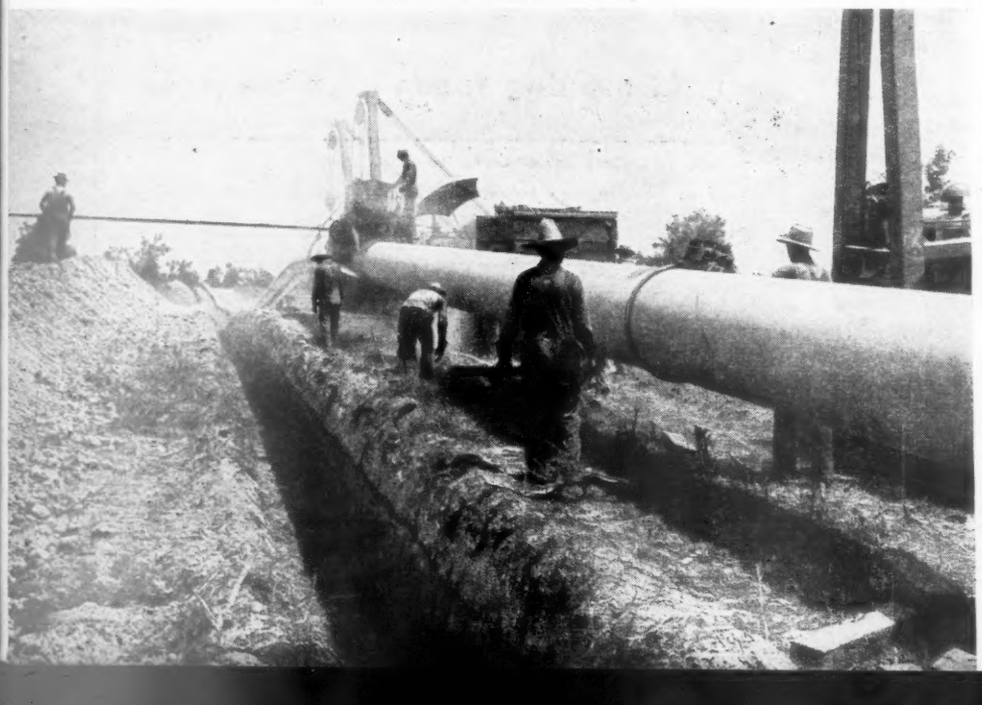
Texas Eastern Transmission Corporation is adding to its system 791 miles of pipe line, 8 compressor stations, and a storage field.

TEXAS EASTERN TRANSMISSION CORPORATION is engaged in an expansion program that will expand its present system by 791 miles of 30-in. pipe line, making an extensive network of 4230 miles of natural gas pipe line. The 30-in. pipe line is the largest expansion engaged in by Texas Eastern since the formation of the corporation in 1947 to purchase the wartime Big Inch and Little Big Inch pipe lines.

From a point near Kosciusko, Mississippi, the new 30-in. line extends in a northeastern direction through the flats of Mississippi, the famous Muscle Shoals watershed in Alabama, bisects the state of Tennessee, crosses the hills and bluegrass section of Kentucky, through southern Ohio, crosses the panhandle of West Virginia, and terminates near Connellsville, Pennsylvania, where it ties into the existing facilities of the company. Its 400,000,000 cu ft daily capacity will increase Texas Eastern's daily delivery capacity to more than 1.2 billion cu ft.

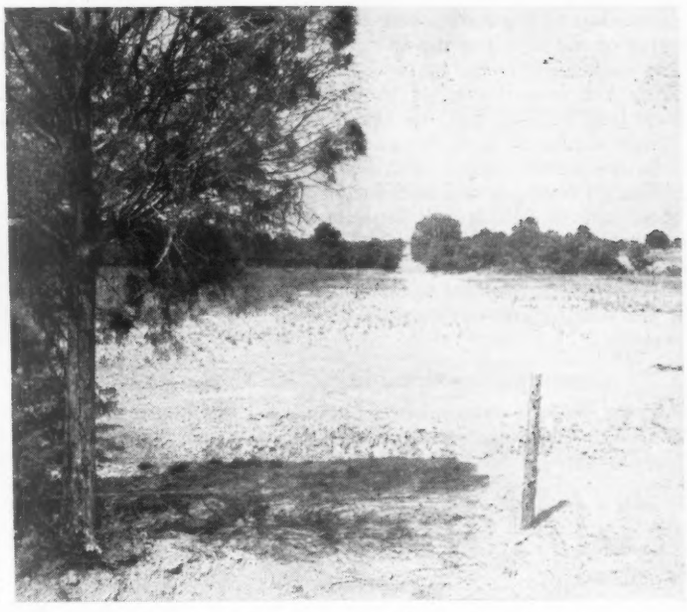
The total cost of the new construction is estimated at $114,300,000. which, in addition to the pipe line, includes 8 new compressor stations, the development of a gas storage field in western Pennsylvania, a 35-mile 30-in. line to the storage field and the conversion of four oil pumping stations to gas compressor stations on existing lines east of Connellsville.

The southern end of the line, near Kosciusko, will tie in with United Gas Pipe Line Company's new line being



A coating and wrapping machine coats the new pipe line with enamel, wraps it in protective layers of glass fiber and heavy kraft paper.

Sideboom tractors lower a heavy section of pipe into ditch prior to welding to a section of line under a Mississippi road.



Scant evidence remains at the outset of the recent pipelaying that took place here. As soon as new grass grows hardly a trace will remain to remind of the construction of Texas Eastern's 30-in. pipe line through this section of Tennessee countryside.

built to bring gas from fields in the Gulf Coastal area. United Gas has contracted to deliver up to 134 billion cu ft of gas per year to Texas Eastern's Kosciusko terminal. At the northern end of the line near Connellsville, the gas will either be placed in Texas Eastern's existing system or will be placed in the company's Oakford storage field to be held for winter demand. Much of this gas will ultimately be sold to Algonquin Gas Transmission Company who will supply eastern New England consumers. Some of the gas will be used to increase the supply available for Texas Eastern's present customers.

The route of the pipe line crosses seven rivers—the Tennessee, Cumberland, Kentucky, Hocking, Muskingum, Monongahela, and Ohio. The Ohio River is crossed twice—at the northern border of Kentucky and the southeastern border of Ohio. In most cases, two lines will be laid as a safeguard against floods.

The new compressor stations on the 30-in. line will provide 53,800 additional horsepower to Texas Eastern's system. The conversion and reactivation of four oil pumping stations and two new stations will provide 50,680 hp, giving the system a total installed horsepower of 381,880.

Both gas-driven reciprocating compressors and electric-driven centrifugal compressors will be installed on the new line. Although two types of stations will be used, the general layout for the stations is similar. Air-cooled seal oil cooling systems will be used on all centrifugal stations, and scrubbers will be used at all stations.

The reciprocating compressor station near Kosciusko will have five 2500-hp Cooper-Bessemer GMW-10 units developing a total of 12,500 hp. The station near Danville, Kentucky, will be an 8800-hp reciprocating station with five Clark 1760-hp HBA-8 units. At Mattes, Pennsylvania, on the existing lines the station will initially be powered by five Clark HBA-6 reciprocating compressors of 1320 hp each and eventually will have 11,880-hp with nine 1320-hp units installed. Near Connellsville, Pennsylvania, where the new line will join the existing system of Texas Eastern, a 4400-hp station will have four 1100-hp Ingersoll-Rand KVG-103 reciprocating units. The easternmost reciprocating station will be at Lambertville, New Jersey, where a 4400-hp station, powered by four Cooper Bessemer gas engine compressors of 1100 hp each, will be erected. Three other stations at Chambersburg, Marietta, and Phoenixville, Pennsylvania, will aggregate 30,000 hp.

Four centrifugal compressor stations will be erected on the 30-in. line and will have DeLaval centrifugal compressors powered by 2500-hp electric motors. Stations at Barton, Alabama, Gladeville, Tennessee, and Wheelersburg, Ohio, will have three DeLaval compressor units with each station developing 7500 hp. The station at Berne, Ohio, will develop 10,000 hp with four DeLaval centrifugal units.

Eight major river crossings, involving seven rivers, will be made by the pipe line. All crossings will be under water, and the pipe will be buried from 3 to 5 ft beneath the river bottoms. River pipe will be concrete-coated to reduce buoyancy.

Following the right-of-way south to north, river crossings are as follows:

Tennessee River—in the vicinity of Muscle Shoals area in Alabama, approximate distance 4000 ft, two crossings—30-in. and 24-in.

Cumberland River—12 miles northeast of Lebanon, Tennessee, approximate distance 800 ft, two crossings—30-in. and 24-in.

Kentucky River—15 miles northeast of Lexington, Kentucky, approximate distance 520 ft, two crossings—30-in. and 24-in.

Ohio River—2 miles south of Wheelersburg, Ohio, approximate distance 2400 ft, two crossings—30-in. and 24-in.

Hocking River—6 miles from Athens, Ohio, approximate distance 220 ft, one crossing—30-in.

Muskingum River—4 miles from Waterford, Ohio, approximate distance 650 ft, two crossings—30-in. and 24-in.

Ohio River—2 miles from Powhatan Point, Ohio, approximate distance 1270 ft, one crossing—30-in.

Monongahela River—12 miles from Uniontown, Pennsylvania, approximately distance 810 ft, one crossing—30-in.

Oakford Storage

Texas Eastern has joined with New York State Natural Gas Corporation, Pittsburgh, Pennsylvania, in developing a 19,000-acre underground storage reservoir approximately 35 miles north of Connellsville.

The reservoir is a substantially-depleted gas field, which had an original capacity of about 500 billion cu ft. Shallow sands extend over the area and more than 200 wells were drilled into the pay zone. At the present time, some of these wells are being plugged and others reworked for injection and removal of gas. In addition, several new wells are being drilled to increase deliverability of gas both to and from the field.

A compressor and injection station costing $7,500,000 will be erected at the field with a total horsepower of 30,000 being supplied by reciprocating gas en-

gines. Cost of the station plus the developing of the field and the 35-mile 30-in. line connecting to the main system will bring the overall cost of the project, including cushion gas, to $40,000,000, jointly shared by both companies.

In the initial stages of the field, 45 billion cu ft of gas will be injected as a base, and 60 billion will be deposited against future withdrawals. The "in storage" gas will provide each participating company access to 30 billion cu ft per year for use during peak demand periods.

Company Background

Texas Eastern Transmission Corporation is a Delaware corporation headquartered in Shreveport. Executive personnel include George R. Brown as chairman of the board; R. H. Hargrove, president; George T. Naff, executive vice president, and E. R. Cunningham, vice president (operations).

Texas Eastern Transmission Corporation was founded in January, 1947. It began operation of the inch lines on a lease basis May 1, 1947, and effected final purchase agreements November 14. A vast program was undertaken to convert these lines into natural gas carriers, and in two years 26 compressor stations were built on the existing lines. The original daily capacity of 138 million cu ft in 1947 was increased to more than 800 million cu ft.

The 24-in. Big Inch extends 1254 miles from Longview, Texas, to Phoenixville, Pennsylvania. From there a 20-in. extension leads to Linden, New Jersey. The Little Big Inch—a 20-in. line—runs from Beaumont, Texas, to Little Rock, Arkansas, and then parallels the Big Inch to Linden, a total of 1479 miles.

When the present expansion is completed, Texas Eastern will have a pipe line mileage of 4230 miles and a total of 38 compressor stations with a combined horsepower of 381,880.

Miles of pipe by size:

30-in. (new construction)	826
26-in.	157
24-in.	1263
20-in.	1657
16-in.	181
under 16 in.	146
Total	4230

Compressor stations:

Type	Number	Installed horsepower
Centrifugal	16	188,500
Reciprocating	10	88,900
Additional:		
Centrifugal	7	62,500
Reciprocating	5	41,980
Total	38	381,880

At Station No. 16 there is one station of each type making 26 stations on only 25 station sites.

Contractors

Brown and Root, Inc., Houston, are general contractors in charge of the entire project and doing engineering and construction work for the new compressor stations.

Major subcontractors for pipe line spreads are Williams Bros.-Davis Company, Houston, 163 miles from Kosciusko to Tennessee River; Eastern Pipe Line Contractors, Dallas, 76 miles from Tennessee River to Columbia, Tennessee; H. B. Zachry Company, San Antonio, 73 miles from Columbia, Tennessee to Cumberland River; Oman Construction Company, Nashville, 79½ miles from Cumberland River to Columbia, Kentucky; N. A. Saigh Company, San Antonio, 82 miles from Columbia, Kentucky, to Kentucky River, and Mahoney Contracting Company, Lansing, 100 miles from Kentucky River to Ohio River, and 35 miles from Connellsville, Pennsylvania, to Delmont, Pennsylvania. (storage line)

A distance of 217 miles between Ohio River (first crossing) and Connellsville has not been contracted as yet. Major subcontractors for river crossings are Tennessee River: Oklahoma Contracting Company, Dallas; Cumberland River: Pentzien, Inc., Omaha, Ohio River (Kentucky-Ohio): Pentzien, Inc., Omaha, and Ohio River (Ohio-West Virginia): Williams Brothers, Tulsa.

* * *

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Petroleum and petroleum products accounted for about four-fifths of all tonnage transported over the New York state barge canal system in 1950.

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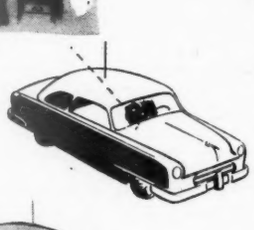

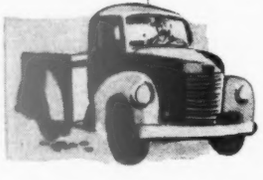

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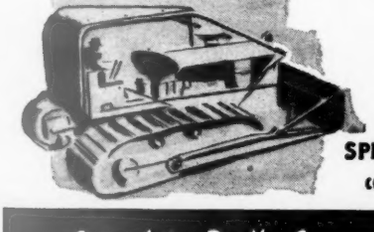

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Important Subjects on AGA Convention Program

Natural gas expansion, utility financing, public relations, and federal controls will head the list of important subjects to be covered at the 33rd annual convention of the American Gas Association at St. Louis, Missouri, on October 15 to 17, inclusive at Kiel Auditorium.

More than 5000 delegates are expected for the meeting. An imposing array of speakers, headed by Senator Everett M. Dirksen of Illinois, and Frank C. Cortright, executive vice president, National Association of Home Builders, has been assembled. The general convention committee under the chairmanship of Robert W. Otto, president, Laclede Gas Company, reports that each of the three general sessions will include nationally known speakers.

D. A. Hulcy, of Dallas, Texas, who is president of both the AGA and the U. S. Chamber of Commerce, is slated to open the convention on Monday morning, October 15, with an address on the prospects and accomplishments of the gas industry.

The close relationship between gas utilities and appliance manufacturers will be spotlighted by Frederic O. Hess, president, Gas Appliance Manufacturers Association and president, Selas Corporation, Philadelphia, Pennsylvania.

Federal controls and credit regulations have restricted construction of new homes in 1951, and next year's picture is uncertain. Cortright, as head of the organized home-building industry and a leading authority in residential construction, will report on the outlook for housing in 1952, at Tuesday's general session. Harry K. Wrench, president, Milwaukee Gas Company, will discuss the importance of natural gas in economic development of gas utilities.

Hulcy will present awards at the general session on Tuesday for outstanding achievements by gas industry members during the past year. The awards include the AGA Distinguished Service Award for the most outstanding contribution to the advancement of the industry; the Beal Medal for the best technical paper presented during the year; the McCarter Medal for successful resuscitations from asphyxiation by gas, and the McCall Awards for exceptional achievements in home service work.

Senator Dirksen headlines the Wednesday morning session with his address on "Citizens' Responsibility." Gas utility companies have serious responsibilities as leaders in their communities, and Senator Dirksen, one of the ablest legislators in the nation's capitol, will suggest paths for the companies to follow. Another timely topic will be a discussion of the vital role of natural gas in national defense by Charles P. Rather, deputy administrator for gas in the Petroleum Administration for Defense, Washington, D. C. Rather doubtless will throw more light on the purpose of PAD restrictions in the use of gas. At the same session, the woman's viewpoint in merchandising gas and gas appliances will be stressed by Clara Zillessen, former advertising manager, Philadelphia Electric Company, in an address, "There is Nothing Like a Dame."

The natural and manufactured gas departments will hold a joint session on Wednesday afternoon, in Assembly Hall 1 of Kiel Auditorium. Presiding jointly will be the chairman of the two departments, George F. Mitchell representing the manufactured gas companies, and Charles E. Bennett on behalf of the natural gas branch of the industry.

One of the most important subjects now before the gas industry is that of public relations, and one of the most far-sighted men connected with the industry has been selected to discuss it. James F. Oates, Jr., chairman, The Peoples Gas Light and Coke Company, Chicago, has long been a leader in good public relations and is one of the strongest advocates of a forceful program for the gas industry. His address is "Public Relations of the Gas Industry."

As the swing to natural gas proceeds throughout the country, more and more companies are becoming concerned with the effect conversion has on the different phases of the company operations. A top executive of one of the leading gas companies in the East will tell what that effect has been on his company.

Most gas companies are finding, as the mobilization program advances, that their activities are being affected by the operations of government agencies. This is particularly true in procuring scarce materials required for transmission, distribution, and other operating supplies. A down-to-earth panel session has been arranged to help gas men in their dealings with government agencies.

Carl Horne, Rheem Manufacturing Company, chairman, AGA residential gas section, will preside at the meeting of the section on Monday afternoon. Irving K. Peck, Manufacturers Light and Heat Company, Pittsburgh, Pennsylvania, will present a profitable pattern for sales. John Knighton, of Servel, Incorporated, is to speak on "Operation Initiative" and present awards to winners of the 1951 AGA-Servel gas refrigerator sales competition.

"Automatic is the 'Buy' Word" will be the topic of James I. Gorton, "CP" Division of GAMA, while Frank L. Seitz, Southern Counties Gas Company, Los Angeles, discusses "Automatic is the 'Sell' Word." The forceful residential sales program will be concluded by an entertaining talk, "The Three Bogeymen," by C. T. Burg, Iron Fireman Manufacturing Company, Cleveland.

The operating section of AGA will meet on Monday and Tuesday afternoons. Committee reports will be made Monday by V. F. Bittner, The Peoples Gas Light and Coke Company, chairman, distribution committee; G. T. Bentley, Michigan Consolidated Gas Company, chairman, gas production committee, and A. E. Sands, U. S. Bureau of Mines, chairman, chemical committee. Service training, natural gas efficiency, and proper gas main sizing will be discussed by speakers, including J. MacLarty, Rochester Gas and Electric Corporation; W. C. Peters, Northern States Power Company; E. G. Boyer, Philadelphia Electric Company, and W. J. Lutz and J. H. Miller, Public Service Electric and Gas Company.

At the Tuesday afternoon meeting committee reports will be made by the following chairman; E. G. Campbell, The Peoples Gas Light and Coke Company, nominating; A. H. Cramer, Michigan-Wisconsin Pipe Line Company, corrosion, and P. W. Rogers, The Ohio Fuel Gas Company, motor vehicles. Irving K. Peck, Manufacturers Light and Heat Company, will tell delegates what management expects from corrosion engineers. Charles F. DeMey, Columbia Gas System Service Corporation, will head a round table discussion on mobile radio telephone equipment. J. W. Carroll, Philadelphia Electric Company, will serve as moderator for a symposium on the effect of natural gas on production plant operation.

The industrial and commercial gas section will meet Tuesday afternoon, with Carl H. Lekberg, Northern Indiana Public Service Company, presiding. Jack Heubler, Surface Combustion Corporation, will speak on gas utilization, and Leon Ourusoff, Washington Gas Light Company, will inform delegates on the competitive commercial cooking situation. As a guest speaker, Herman Koester, Jr., W. Wirt Young and Associates, Wellesley Hills, Massachusetts, will speak on "Sales Techniques."

A joint luncheon meeting of the residential and the industrial and commercial gas sections will be held on Wednesday at the Jefferson Hotel, with Messrs. Horne and Leckberg acting as co-chairmen. The guest speaker will be Joseph F. Holland, a public relations executive from St. Louis.

Two concurrent group meetings will be sponsored by the accounting section at the Auditorium on Monday afternoon. Carter E. Shields, Michigan Consolidated Gas Company, will preside at a meeting of the general activities group. His speakers will include J. K. Laurentz, the Brooklyn Union Gas Company; J. J. Trebilcott, Michigan-Wisconsin Pipe Line Company, and W. G. Marbury, Mississippi River Fuel Corp., St. Louis.

The customer activities group will meet Monday afternoon. Something new at AGA Conventions, a luncheon meeting for corporate secretaries, will be held Wednesday. The accident prevention committee will hold a meeting on Wednesday also.

NEWS

Ector County Compressor Station for El Paso

The Federal Power Commission has authorized El Paso Natural Gas Company, of El Paso, Texas, to construct a 1980-hp compressor station near the Shell Oil Company's TXL plant in Ector County, Texas.

The commission at the same time found that El Paso will not need FPC authorization for the construction of an 1100-hp compressor station near Phillips Petroleum Company's gasoline plant in Gaines County, Texas. The commission said that all the gas will be produced, transported and consumed entirely in Gaines County, and that the proposed station is not a facility for the transportation of natural gas in interstate commerce and will not be used as an integral part of El Paso's system.

The compressor station to be built in Ector County will be used to transport an additional 17,800,000 cu ft of natural gas a day from the Shell Oil plant to El Paso's Keystone plant in Winkler County, Texas, through two existing lines. Estimated cost of the construction in $453,000.

The other compressor station, for which no authorization is required, will increase the capacity of the pipe line between Phillips' Seminole plant and Columbian Carbon Company's plant from 18,300,000 cu ft a day to 28,200,000 cu ft. This line is owned by Columbian and the entire volume of gas to be transported through the proposed compressor station and through the line will be consumed at the Columbian plant. Estimated cost of this compressor station is $291,000.

IGT Graduates 12 With Master's Degrees

The Illinois Institute of Gas Technology graduated 12 students with masters of gas technology in the class of '51. Although these numbers are not large when compared with some universities, analysis reveals that they are remarkable for a school as young and specialized as the Institute. IGT admits only selected Fellows as students, and requires two years of study for a master's degree and an additional two years for a doctorate. The student quota is 15 new men a year.

The 12 who received master's degrees are: Charles William Ade, Moline, Illinois; Donald Walker Bahr, Chicago; Charles Edward Brooks, Pittsburgh, Pennsylvania; Richard Francis Bukacek, Cedar Rapids, Iowa; Henry Stanley Droby, Pawtucket, Rhode Island; Orin Flanigan, Monroe, Louisiana; Kenneth Emanuel Glessner, Chambersburg, Pennsylvania; John Howard Kerstetter, Toledo, Ohio; Basil Peter Mann, Chicago; John Frederick Schomaker, Jr., Klamath Falls, Oregon; Frederic Paul Wehrle, Denver, Colorado, and Gerald Gene Wilson, Blue Hill, Nebraska.

W. C. Jackson, center, Los Banos, California, receives the Joseph A. Holmes Safety Assn. Medal of Honor from S. F. Bowlby, left, Los Angeles area vice president for Shell Oil Company. Mining Engineer S. S. Crawford, right, was on hand to represent the U. S. Bureau of Mines in San Francisco, which makes the Holmes award.

W. C. Jackson Receives Bureau of Mines Award

In recognition of his heroic action without regard for his personal safety, W. C. Jackson of Los Banos, California, received the Joseph A. Holmes Safety Association Medal of Honor at a luncheon held in his honor at the Ambassador Hotel in Los Angeles.

Jackson, an engineer for Shell Oil Company, pipe line division, was awarded the medal for his successful efforts to save the lives of two truck drivers pinned in a burning truck on October 17, 1950, near Gustine, California.

The Holmes award, which was presented to Jackson by S. F. Bowlby, Los Angeles area vice president for Shell, is given each year by the U. S. Bureau of Mines for outstanding acts of heroism. Only 7 were presented in the United States for 1950.

Also present at the meeting were A. J. Galloway, Shell's vice president for exploration and production, from New York; S. S. Crawford, mining safety engineer from the U. S. Bureau of Mines in San Francisco; L. R. Newfarmer, exploration manager for Shell in Los Angeles, and R. S. Tulin, Shell's Los Angeles natural gas and gasoline division manager.

Newfarmer received an award from the National Safety Council, and Tulin an award from the Bureau of Mines for safety records in their departments.

Fish Studying Refueling Of Jet Aircraft For Navy

Fish Engineering Corporation, Houston, Texas, has been commissioned as consulting engineers to make a study and recommendations on rapid refueling of jet aircraft. The contract is with the Bureau of Yards and Docks of the U. S. Navy Department.

Service Purchases Two Oil Gathering Systems

Service Pipe Line Company recently took over operation of two West Texas crude oil gathering systems obtained from Magnolia Pipe Line Company and B. C. Pipe Line Company, C. M. Scott, Tulsa, general manager, announces.

The system formerly owned by Magnolia Pipe Line serves the Dean (West Levelland) area. It includes approximately 25 miles of a 2 to 4-in. pipe connecting 94 wells on 22 leases producing approximately 1600 bbl of oil a day, subject to Texas Railroad Commission allowables.

Purchased from B. C. Pipe Line Company are gathering facilities connecting the Yellowhouse pool in Hockley county with the Consumers Cooperative refinery at Levelland.

Texas Pipeline Promotes Top Operating Personnel

A series of promotions of top operating personnel of The Texas Pipe Line Company and Texas-New Mexico Pipe Line Company is announced by R. B. McLaughlin, president of the companies.

It also is announced that E. R. Osburn, assistant general manager of both companies, has retired from service because of physical disability.

All the changes are in effect now, as follows:

L. F. Scherer, advanced from chief engineer to assistant general manager (in charge of construction and engineering), The Texas Pipe Line Company and Texas-New Mexico Pipe Line Company.

R. B. Trow, who was promoted from assistant chief engineer to chief engineer, engineering division of the two companies.

R. W. Olbrich, moved up from special projects engineer to acting assistant chief engineer, both companies.

C. H. Albitz, promoted from division manager, oil traffic division, to assistant general manager of the two companies.

W. C. Montgomery, advanced from assistant division manager to division manager, oil traffic division.

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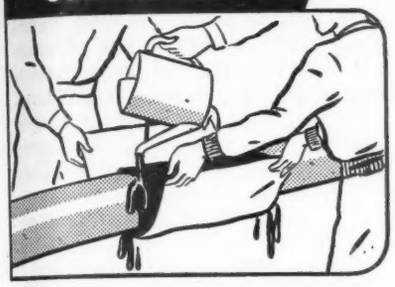
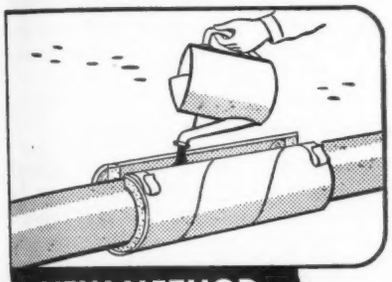
OLD METHOD





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"Field-Jointer" construction features heavy, rigid, paper mould equipped with felt inserts for each end, preventing waste, plus heavy adhesive tape fasteners. One-quarter inch spacing between pipe and mould gives positive assurance of protection. Slip on—Pour full—Lower in.

The "Field-Jointer" represents a new technique of coating field joints and skid-marks with the same material used on pipe at the coating machine. Slip-on "Field-Jointer" over joint, pour enamel, fasten, and you are ready to lower-in. The canvas sling method is slower, and does not provide assurance of adequate protection for pipe bottoms. Use of "Field-Jointer" provides following features for field use.

- ★ **Eliminates waste of material**
- ★ **Eliminates clean-up operations**
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- ★ **Affords positive proof of pipe-bottom protection**
- ★ **Prices and additional information, plus arrangements for field demonstrations furnished on request.**

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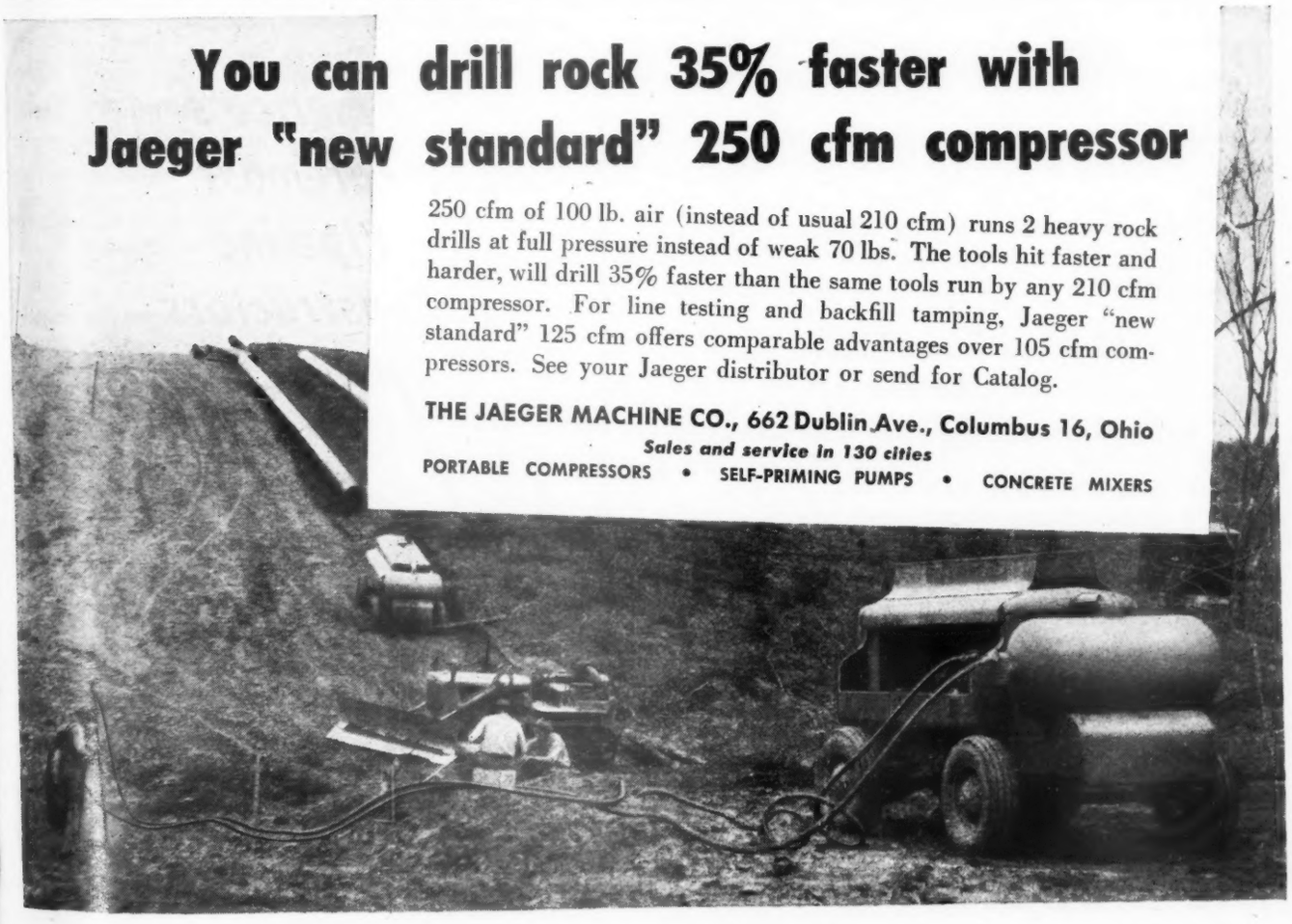

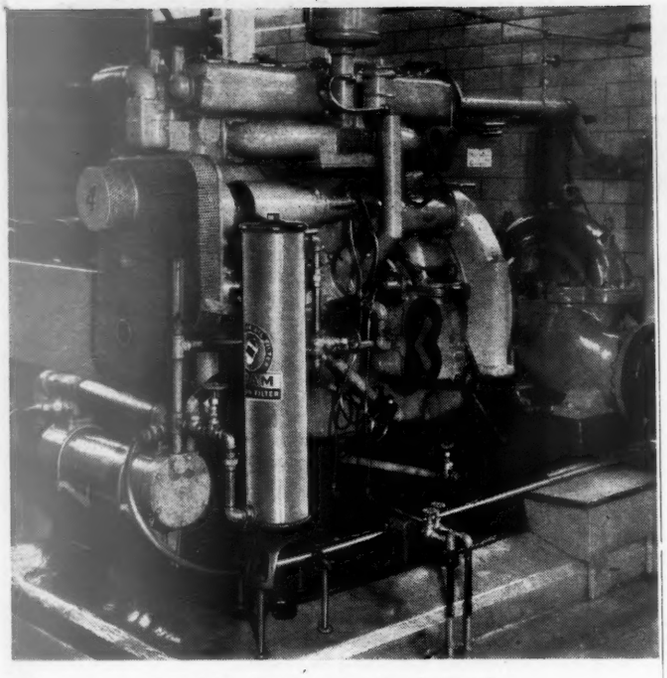

Fram Filter Installation on Murphy Diesel at New London, Conn., Waterworks

FRAM Filters Assure Dependable Diesel Operation at Pumping Station

PUMPING STATION Supervisor Walter F. Mahoney says words cannot express the excellency of Fram Filters. This station operates 24 hours a day, 7 days a week, pumping water from reservoir into large storage tanks which supply New London, Conn., with water. Reliable operation is vital. Without it, the city would be without water. Fram Filters remove sludge, grit, abrasives and other impurities from lubricating oil, prolong engine life, cut down-time and maintenance costs.

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Retirements Announced

Raymond M. Bayless, superintendent of the communications and electrical department of Humble Pipe Line Company, Houston, Texas, has retired after 32 years' service. He has been in the communications business for 50 years, having begun as a night telephone operator in a small exchange while going to school during the day. In 1919, he joined Humble as head of the communications department. His first job was building a short telephone line between Goose Creek and the Baytown Refinery site. Humble's entire present communications system was constructed under Bayless' supervision.

Benjamin F. Kemp, mechanical supervisor at Hull, Texas, for Humble Pipe Line Company, has retired after 18 years' service with the company. While with Humble he has worked at Conroe, Houston, Webster, Pierce Junction, Sugar Land,

R. C. Henderson, assistant general superintendent of compressor stations for United Gas Pipe Line Company, has retired after 24 years' service. Henderson worked for Ford, Bacon and Davis in the mid-twenties during construction of the gas properties of United in the Baton Rouge area and became chief engineer of the Scotland compressor station when it was completed. In March, 1945, he was transferred as chief engineer to the Mineola station in the Dallas district and remained there until June 1, 1947, when he moved into the Shreveport general office as assistant general superintendent of all the company's stations.

Propose Pipe Line and Station Purchase

An application has been filed with the Federal Power Commission in connection with the proposed purchase by Manufacturers Light and Heat Company, of Pittsburgh, Pennsylvania, of nearly 136 miles of natural gas transmission lines and the 2400-hp Carnegie compressor station, all in West Virginia, from United Fuel Gas Company, of Charleston, West Virginia. Estimated original cost of the property is $3,638,728, with an estimated depreciation of $572,748.

America's Foremost Pipeline Constructors

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H. C. PRICE CO.
PHILADELPHIA BARTLESVILLE NEW ORLEANS

Sinclair Pipeliner Gets Safety Council Medal

The National Safety Council's President's Medal, given for meritorious safety service, was presented to a Sinclair Pipe Line Company employee in an appropriate ceremony at Independence, Kansas.

Roy J. Tibbets, Sinclair Pipe Line Company president, made the presentation of the medal to Harry E. Lybarger, Blackwell, Oklahoma, during a special meeting of the company board of directors, officials, and department heads.

Lybarger's quick thinking and know-how is credited with saving the life of a co-worker, George W. Murphy, also of Blackwell.

Murphy, a connection foreman, and others in his gang were burning waste oil and putting out back fire grass near Garver, Oklahoma, last January 10. Murphy was found by fellow employees lying in the grass and unconscious. From all appearances, he had no pulse or heart beat and his face was turning a dark purple, it is said.

Lybarger started artificial respiration and continued it until Murphy was successfully resuscitated.

A physician, who was called to the scene, said that Murphy apparently suffered from an acute irregular decompensation of his heart, causing unconsciousness which probably would have been fatal, had he not been given artificial respiration to revive him.

The Sinclair Pipe Line Company emphasizes a safety program and provides qualified instructors to carry on the many phases of the program.

Harry E. Lybarger, left, being congratulated by Roy J. Tibbets, Sinclair Pipe Line Company. On the right is C. H. Lindberg, safety director for the company.

Shell Expands Willbridge Terminal in Oregon

The Shell Oil Company has completed a multi-million dollar expansion program at its Willbridge Terminal on the Willamette River in northwest Portland, Oregon.

The terminal, which is the second largest operated by Shell in the entire country, serves as the distributing center for petroleum products delivered to the major portions of Oregon, Washington, and Idaho.

During the three-year expansion program, petroleum processing facilities have been considerably enlarged and storage capacity increased by more than one-third, according to the Portland division manager, George V. Birkinshaw.

Products processed at Willbridge include various grades of lubricating oils and 21 different paving grades of asphalts and road oils.

Willbridge now has a total storage capacity of over 50,000,000 gal and each day distributes upward of 1,000,000 gal of petroleum products in the Pacific Northwest.

The Willbridge Terminal was first opened in the early 1910's and today employs 175 men with an annual payroll approximating $1,000,000, according to plant superintendent, W. L. Shaw.

Interstate Oil Pipe Line Into Shreveport Headquarters

Consolidation of Interstate Oil Pipe Line Company's Tulsa and Shreveport organizations in Shreveport, Louisiana, was completed the early part of September.

This is the complete consolidation that was contemplated when Interstate acquired the pipe line properties of Standard Oil Company of Louisiana on January 1, 1945, but which was delayed by the war and postwar conditions.

Under the consolidation plan, general offices of the company have been transferred from Tulsa, Oklahoma, to Shreveport, and the various staff and corporate functions that have heretofore been duplicated in the two divisional organizations combined and consolidated in the Shreveport headquarters. The two-division organization is being retained, however, for the operation of the company's crude oil pipe line system.

Tulsa continues to be operating headquarters of the Northern Division, which includes crude oil pipe line operations in Oklahoma, Illinois, Montana, and Wyoming. Shreveport is operating headquarters of the Southern Division system, which includes properties in Arkansas, Louisiana, and Mississippi.

Heading the general office and corporate staff in Shreveport is Joseph L. Seger, former Tulsan who was elected president on July 1. Assisting Seger in an advisory and consulting capacity will be Smith W. Day, Shreveport, vice president and veteran of some 46 years' service with the company, who has been serving as head of the Southern Division.

Other members of the corporate staff include P. H. Hunter, secretary-treasurer; J. W. Cason, comptroller; Sequoyah Brown, employee relations manager, and Dr. R. M. Adams, medical director. All members of the corporate staff have their headquarters in Shreveport, and all except Day formerly held similar positions in Tulsa.

Operations of the company's extensive pipe line facilities is in charge of Vice President Bruce Ramsey, former head of the company's Northern Division organization who is now vice president and general manager in charge of operations.

Ramsey's staff includes H. P. Hellinghausen as manager of material; E. M. Henderson, chief engineer, and W. F. Davis, traffic manager.

General supervision over the operations of the two divisions is exercised by two division managers. J. M. Bradley, former operations assistant to the president, serves as manager of the Northern Division and maintains headquarters in Tulsa. The Northern Division staff in Tulsa, composed of approximately 20 employees, includes George Randels, former northern division general superintendent who has been on loan to Interprovincial Pipe Line Company, as assistant division manager; S. C. Phelps, former northern division engineer and acting general superintendent, as division engineer; Noble F. Jones, who continues in his former position as division employee relations manager, and Leo F. Haas, former northern division chief accountant, as division chief clerk.

Southern Division operations are in charge of S. R. Simmons, former assistant manager and general superintendent of the Southern Division, who is now division manager. Simmons has two assistant division managers; S. A. Sheppard, former assistant general superintendent of the Southern Division, and Joe C. Rawlins, former assistant to the Southern Division general manager.

In Shreveport, company offices are in the Interstate Building on Market Street, which has been extensively remodeled in advance of the move. The building has served as headquarters of the Southern Division, formerly in pipe line department of Standard Oil Company of Louisiana, for many years.

Other former occupants of the Shreveport office building, The Carter Oil Company and Esso Standard have moved into other quarters in Shreveport.

TGT Completes First Hydrocarbon Recovery Units

Construction of initial units of a $10,000,000 Tennessee Gas Transmission Company liquid hydrocarbon recovery plant near Gabe, Kentucky, has been completed and operation has begun on a limited scale, it was announced at company headquarters in Houston, Texas, by C. S. Coates, vice president.

The plant will process a large portion of the natural gas passing through the Tennessee Gas pipe line system toward the Appalachian area and the East. The gas will be diverted through the plant and then returned to the pipe line system to continue its journey with no appreciable reduction in the high quality of the gas for fuel purposes.

Activity and production at the plant will increase later in the year as additional units are completed at the plant and at the new chemical plant of the Mathieson Hydrocarbon Chemical Corporation, which will take all the output of the Tennessee Gas plant.

When in full operation the extraction plant, commonly called a "stripping" plant, will process about 750,000,000 cu ft of gas daily from which will be obtained approximately 380,000 gal of liquid hydrocarbons daily, according to Joe J. King, company chief engineer. The plant will extract about 16 per cent of the ethane from the gas and substantially all the propane, butanes, hexanes, and heavier hydrocarbons present.

The liquid hydrocarbon stream will be delivered by a 58-mile 8-in. pipe line to the new $17,000,000 Mathieson Hydrocarbon plant on the Ohio River near Brandenburg, Kentucky, already partially in operation.

Pending completion of the chemical plant, it is receiving a limited amount of ethane, propane, and heavier hydrocarbons from the Tennessee Gas "stripping" plant. This liquid stream is being fractionated at the Brandenburg plant into liquefied petroleum gas and natural gasoline.

On completion of both plants later this year, the ethane content of the liquid stream from the Tennessee Gas plant will be increased to design quantity. At the Mathieson Hydrocarbon plant the stream will be separated by fractionation into ethane, propane, butanes, and natural gasoline.

The ethane will then be ready for the cracking furnace, where it is converted into several gases including ethylene, which becomes the material from which stems almost countless chemical end products.

By-products will include propane, butanes, and natural gasoline. Chemicals will include ethylene glycol (antifreeze), ethylene oxide, and other products. The products of the plant will be used in the manufacture of synthetic fibers such as orlon and dynel; hydraulic fluids, bottle gas, synthetic rubber, and high-octane aviation gasoline.

Equipment for Pipe Line

Westinghouse Electric Corporation will supply approximately $1,160,000 worth of electrical equipment for a new 550-mile common carrier pipe line linking the West Texas fields with refineries and pipe line connections in the southern and eastern parts of the state.

Five companies will pump crude oil from their producing fields to a tank farm at Colorado City, where the first station of the new line will give the oil an 800-psi "push" through 134 miles of 26-in. line to Ranger. Booster pumps will add a like pressure to carry the oil another 142 miles to Wortham, about 60 miles south of Dallas. Here, the system will divide into a 114-mile, 20-in. line to Longview, and a 164-mile 24-in. line to Lucas, near Beaumont.

The pipe line will have the latest refinements in motors for centrifugal pump drives, with centralized control automatically sequencing each pump motor through its associated valves and auxiliaries. It will feature the largest concentration of remote tank farm and pump manifold controls thus far centralized on a control console. The consoles will be of the piping-diagram type, and one of them will control more than 100 valves and 11 booster pumps.

Initially, three pumping stations will operate the system at about 300,000 bbl a day. Design and construction of the line is being handled by the Gulf Oil Corporation.

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TET Construction to Be Completed in Spring

R. H. Hargrove, president of Texas Eastern Transmission Corporation, summarized the current status of the $114,300,000 construction program of the company in an address recently at a noon luncheon meeting of the Los Angeles Society of Security Analysts. Completion of the expansion program will result in a total system of more than 4200 pipe line miles and calls for sales at the rate of 1.2 billion cu ft of gas per day, he said.

"Our present schedule calls for the completion of the new natural gas pipe line as far north as the first crossing of the Ohio River by January, 1952," Hargrove said, "and we hope to complete this entire Texas Eastern project by spring of next year."

Texas Eastern's current expansion consists of the construction of 791 miles of 30-in. pipe line from Kosciusko, Mississippi, to a tie-in point with the corporation's existing pipe lines near Connellsville, Pennsylvania, and the development of a 19,000-acre natural gas storage field in western Pennsylvania. Included in the project is the construction of 12 compressor stations on the new line and the existing lines east of Connellsville, and the construction of 35 miles of 30-in. line from Connellsville to the storage field.

Oakford Storage is a joint ownership operation between Texas Eastern and New York State Natural Gas Corporation of Pittsburgh. The 30-in. line to Oakford Storage is nearing completion with all of the line now in the ground Hargrove reported.

The construction area south of the Ohio River is divided into seven pipe line jobs. All seven contracts have been awarded and construction is underway on all jobs. Contracts for the three jobs north of the first Ohio crossing have not yet been let. A total of about 180 miles of line has been laid to date.

Eight river crossings, involving seven rivers — the Tennessee, Cumberland, Kentucky, Hocking, Muskingum, Monongahela, and Ohio — are separate construction projects. Contracts have been awarded on five of the crossings, which include both crossings of the Ohio and all rivers south of the Ohio.

Texas Eastern's 30-in. line will tie-in near Kosciusko, Mississippi with a new line that United Gas Pipe Line Company is laying to supply gas under a contract calling for delivery of up to 134,000,000,000 cu ft of gas per year to Texas Eastern Transmission's Kosciusko terminal.

In this talk to the analysts, Hargrove reviewed the growth of the natural gas transmission industry with particular emphasis on Texas Eastern's part in that development.

Imperial Oil Forms Pipe Line Department

Formation of a new operating department to be known as the pipe line department was announced today by Imperial Oil Limited, Toronto, Canada. The manager will be F. C. Lantz, who has held the position of assistant to the vice president (transportation).

The new department will be responsible for pipe lines owned by Imperial Oil and for Imperial's interest where it is a part owner of other pipe line companies.

Sunray Products Line Gets Booster Station

A temporary booster station on the Sunray Pipe Line Company's products line from Allen to Duncan has been put into operation at Bearden, Oklahoma.

This booster station is to be operated as a permanent installation in an expansion project scheduled for completion in early fall. The temporary station has already increased the throughput of Sunray Pipe Line Company's products line from Allen to connection with Great Lakes Pipe Line system at Drumright by approximately 6000 bbl of products a day. The new installation makes possible the transportation of 35,000 bbl a day through the company's Allen to Drumright products line.

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J. B. Ferguson Is Chief Engineer Link Radio

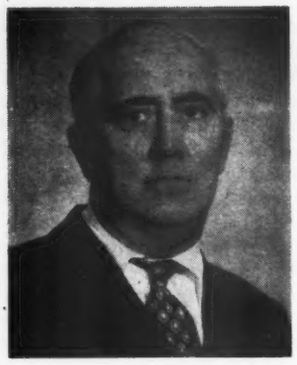
Announcement was made recently by the board of directors of Link Radio Corporation, 125 West 17th Street, New York City, designers and manufacturers of electronic communications equipment since 1932, of the appointment of James B. Ferguson of New York City as chief engineer of the organization.

Since Ferguson joined Link Radio as consulting engineer in June, 1950, he has designed the new Link mobile radio transmitter-receiver units, such as the Link Expediter Type 2750 for adjacent channel operation, now in full production at the Link plant. Ferguson is a veteran in the radio business. He was one of the first 100 men in this country to receive a commercial radio operators' license in 1912. In those early days of radio, he also was in the wireless operator section of the American-Hawaii Steamship Company.

From 1918 to 1920, he was a radio engineer in the U. S. Navy Department. From 1920 to 1923, he was vice president and general manager of the Ship Owners' Radio Service. For 12 years, from 1923 to 1935, he was president and chief engineer of J. B. Ferguson, Inc., and Ferguson Radio Corporation. In 1935, he became director in charge of engineering and production of Ferguson Radio Corporation, Ltd., in England. In 1941, he became general manager of the U. S. Television Manufacturing Corporation. One year later, he became manager of the production division, Press Wireless, Inc. From 1944 until he joined Link Radio, he was chief engineer of the communications division of Belmont-Raytheon.

Ferguson has made the following staff appointments: Frederick A. Schaner, assistant chief engineer in charge of governmental development; Harold M. Heimark, assistant chief engineer in charge of commercial development, and J. W. Campbell, assistant chief engineer in charge of engineering coordination and services.

Schaner graduated with a B.S. degree in electrical engineering from the Drexel Institute of Technology in Philadelphia. Before joining to Link Radio, he was project engineer with Air Associates, Inc., of Orange, New Jersey. He also was chief factory engineer several years ago with Majestic Radio and Television at Elgin, Illinois.



J. B. Ferguson

Heimark has been in two-way radio design since 1933. He is a nationally known consultant on two-way radio, specializing the last few years on miniature and sub-miniature communications designs in the upper frequencies, mainly 160 and 450 megacycles. He was formerly chief engineer of the Florida Highway Patrol and also was chief engineer of Doolittle Radio Corporation.

Campbell has been with Link Radio since September, 1940. After working in the wiring section, he soon became a design engineer. He added to his technical knowledge with courses pursued at De Forest Training Institute.

Ohio's Crude Oil Line Nears Spring Completion

Construction of the final portion of The Ohio Oil Company's "big inch" crude oil pipe line between Wood River, Illinois (St. Louis area) and Lima, Ohio, will begin early in October, O. F. Moore, manager of the company's pipe line department, announced.

The contract for laying 117 miles of 22-in. line from Sheridan, Louisiana, to Lima has been awarded to Conyes Construction Company. It is expected to be completed and ready for use early in 1952. The Wood River to Sheridan portion of the line has been in service since last June. The 22-in. line from Martinsville to Lima will have a potential capacity of 250,000 bbl per day.

Vehicular Communications Group Meets in Chicago

Commissioner Edward M. Webster of the Federal Communications Commission is the principal speaker at the annual conference of the Institute of Radio Engineers Professional Group on Vehicular Communications, in Chicago, October 25 and 26. Webster will speak at an informal dinner held Thursday evening, October 25.

Ten technical papers of current interest to persons associated with mobile communications will be presented during the sessions, as follows:

1. "Station Antennas for Vehicular Communications"—George C. Terrell, Workshop Associates.
2. "Receiver and Systems Design Requirements for Adjacent and Split-Channel Operation"—Lloyd P. Morris, Marion E. Bond, and John F. Byrne, Motorola, Inc.
3. "Civil Defense Communications Planning"—R. H. Roberts, Federal Civil Defense Administration.
4. "Adjacent Channel Design in the Westinghouse Type FE Heavy Duty Railroad Radio"—A. A. Macdonald.
5. "Split-Channel Operation of Radio Communication Equipment"—H. H. Davids, General Electric Company.
6. "Mobile Antennas for Vehicular Communications"—M. R. Friedberg, Ward Products Corporation.
7. "The Blasting Cap Hazard in Mobile Radio"—C. P. Williams, E. I. Dupont Company.
8. "Lightning Protection for Mobile Radio Fixed Stations"—D. W. Bodle, Bell Telephone Laboratories.
9. "Unidirectional Antennas for 450 mc."—J. S. Brown, Andrew Corporation.
10. "Dry Battery Operated Radio Equipment for Forestry and Emergency Communications"—H. K. Lawson, U. S. Department of Agriculture.

Two Pipe Lines Given Steel Allotments

Fourth quarter allocations of steel will be made to the West Texas-Gulf Pipe Line Company and Platte Pipe Line Company for pipe lines to provide an outlet for crude in areas where crude is in excessive supply.

Petroleum Administration for Defense has allotted 22,000 tons of steel to West Texas-Gulf Pipe Line, owned jointly by Gulf, Sohio, Sun, Pure, and Cities Service. The line will have a capacity of 301,000 bbl a day to Wortham, Texas, where it will divide with one branch going to the Gulf Coast near Houston and another connecting with the Mid-Valley line to Lima, Ohio. The line, which will require 130,000 tons of steel, is expected to be completed in the third quarter of 1952.

PAD also alloted 52,000 tons of steel for fourth quarter delivery to the Platte Pipe Line Company extending from Wyoming to Wood River. An additional 100,000 tons of steel will be needed to complete the line, it is estimated.

Sterling Oil Signs Natural Gas Contract

Sterling Oil of Oklahoma, Inc., Tulsa, has signed a three-year contract with Northern Oklahoma Gas Company-Kay County Gas Company, Ponca City, Oklahoma, to purchase a minimum of 10,000,000, and up to a maximum of 25,000,000 cu ft of natural gas per day, it is announced by Jesse A. True, president. This gas will be sold to various industrial plants and private homes in north central Oklahoma. Right-of-way for gas transmission pipe line is being acquired and the line will be laid when obtained.

The gas is to be obtained from Sterling's No. 1 Brunken well, South Spring Valley pool, Garfield County, Oklahoma. The company is expected to drill four or five additional wells in this pool by the end of the year. An estimated 25 to 30 bbl of distillate per million cubic feet of gas will be made from this well alone.

Sterling is presently negotiating with the Cities Service Gas Company to purchase natural gas from its No. 1 Anderson well in the Northeast Sporn pool, Payne County, it was also stated by True. This contract is to be signed shortly by officials from both of the companies.

The well has been completed for 33,000,000 cu ft of gas a day from the Red Fork sand at 4000 ft. Gas lines are to be laid and connected during the month of September.

Sterling's holdings are approximately 440 acres in this structure, and additional wells will be drilled around this discovery pool. The No. 1 Anderson well also makes an estimated 25 to 30 bbl of distillate per million cubic feet of gas.

Phillips Financing Includes 500-Mile Line and Stations

Phillips Petroleum Company and its subsidiary Phillips Pipe Line Company recently completed arrangements for additional lines of bank credit on a standby basis that will enable the borrowing of funds from time to time as occasions for their use arise, according to K. S. Adams, chairman, and Paul Endacott, president, of the parent company. They stated further that at no other time in the company's history has there been so large a backlog of attractive opportunities to place existing reserves of raw materials and product supplies on a long-term income-producing basis.

Since the first of this year, the company's long-term debt has been reduced, principally through conversions and redemptions of outstanding 2⅜ per cent convertible debentures, so that the original issue of $75,644,900 had declined to $16,617,000 by the date of September 7, 1951.

One part of the standby bank credit is for Phillips Pipe Line Company and provides for a maximum of $30,000,000 repayable over 7¼ years starting January 1, 1953. The major part of these funds will be used for more than 500 miles of additional 8-in., 10-in. and 12-in. pipe, together with necessary pumping stations and tanks to increase by 30,000 bbl per day the capacity of the existing products pipe line system from Phillips, Texas to East Chicago, Indiana, which is now handling 85,000 bbl per day.

The remaining standby credit is for Phillips Petroleum Company and provides for a maximum of $75,000,000 repayable from June 30, 1953, to December 31, 1957. The proceeds from this borrowing will be available if desired for various new projects to manufacture chemical, extract natural gasoline and liquefied petroleum gases, gather and process natural gas, eliminate operating bottlenecks in existing facilities, and complete an extensive refinery expansion and improvement program. The company recently announced construction of two large plants for the extraction of natural gasoline and lighter hydrocarbons from gas produced in the Spraberry Trend of West Texas.

During the five-year postwar period 1946 to 1950, inclusive, Phillips applied a total of $456,548,000 to capital expansion. Gross income rose from $222,000,000 in 1946 to $534,000,000 in 1950. Capital expenditures during 1951 are now estimated at $140,000,000, as compared with $92,644,000 in 1950, and 1951 gross income is expected to reach $600,000,000.

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PIPELINE PERSONALS

Ralph K. Willis and **John W. Maddox** have been made chief engineer and assistant chief engineer, respectively, at the Centralia, Missouri, compressor station of Panhandle Eastern Pipe Line Company. Willis formerly was assistant chief engineer there and Maddox machinist first class. Willis has been with the company almost 15 years. He began working as an oiler at Louisburg, Kansas, October 1, 1936, and was transferred to Greensburg in 1944. He became assistant chief engineer at Centralia December 1, 1945. Maddox became associated with the company at Centralia station August 8, 1937, and has been there since, assuming the duties of machinist first class December 8, 1944.

J. A. "Kenny" Edinborgh has joined the staff of Shell Pipe Line Corporation's head office engineering department as electronics engineer and has been assigned to the Experimental Engineering Laboratory in Houston, Texas. Prior to joining Shell he was associated with the Wichita (Kansas) Research Laboratory.

Neil G. Wilson is another new man in the head office engineering department. He was employed as a junior chemical engineer and has been assigned to the Experimental Engineering Laboratory. Before going with Shell he was with Pittsburgh Plate Glass Company.

R. W. Phillips has been made chief engineer of The Texas-Empire Pipe Line Company and the Kaw Pipe Line Company, with headquarters in Tulsa, Oklahoma. He has been assistant chief engineer. D. B. Good has been named assistant chief engineer.

J. G. Lowrance, formerly of Carrollton, Missouri, has been appointed industrial relations supervisor for the Nebraska division of the Service Pipe Line Company, O. O. McKenzie, division manager, announced.

Lowrance joined the Missouri division of the company in 1940 and worked in various posts in Missouri and Illinois. In August, 1950, he went to the pipe line company's general office in Tulsa as a job analyst. Prior to his appointment, he studied a course in industrial relations at Tulsa.

Dorman D. Day has been promoted from district engineer in the Kermit district to assistant superintendent of the Vanderbilt natural gas district by the Magnolia Petroleum Company. He will have his headquarters at Vanderbilt, Texas.

Henry A. Jacobs has been promoted by Transcontinental Gas Pipe Line Corporation from assistant to division superintendent of Division 5. He has moved his office from Bridgeport, Pennsylvania, to Linden, New Jersey.

W. H. Adams, Pittsburgh, Pennsylvania, has been named safety consultant by the American Gas Association for its member companies. Adams, who has been safety director of the Manufacturers Light and Heat Company, assumed his new post at AGA headquarters in New York on September 1.

An enlarged and intensified accident prevention program for gas utilities will be conducted by the association under Adams' direction. He will analyze successful safety programs of member utilities, and disseminate safety information to the industry. The preparation of safety films, posters, and training material, as well as specific safety plans for individual companies, are included in Adams' duties in his new safety assignment.

For the past year and a half Adams has been chairman of AGA's Accident Prevention Committee, which has laid the groundwork for the enlarged program. He has now been granted an extended leave of absence from his position in Pittsburgh to set up and develop the accident prevention activities of AGA.

A native of Fremont, Ohio, Adams has had wide experience in both manufactured and natural gas operations with utilities. He entered regular employment with the Citizens Gas and Electric Company in Ohio in 1905. He joined the Ohio Fuel Gas Company in 1927, and since 1935 has served as safety director for utility companies in the Pittsburgh group of the Columbia Gas System, operating in five states.

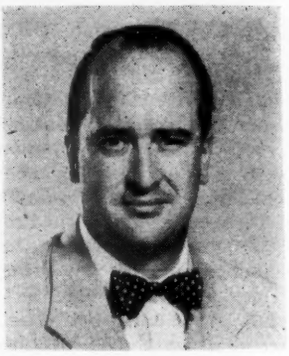
D. F. Cooledge, district chief gager, at Hendricks, Texas, for Shell Pipe Line Corporation, has been transferred to the same position at Penwell.

D. A. Heatherington, pipe line maintenance foreman, has been moved from Colorado City, Texas, to McCamey.

E. L. Martin, assistant pipe line maintenance foreman at Eunice, New Mexico, has been made pipe line maintenance foreman at Colorado City.

O. O. Morgan, district chief gager, has been transferred from Penwell to Hendricks.

Jess B. Barnett, former district superintendent of line and tank maintenance for Interstate Oil Pipe Line Company, has been named superintendent of the newly formed Southern Main Line District. This district was created recently when the Southern Division Main Line was classed as a district. In his new position Barnett will have supervision of all main line stations from the Oklahoma state line to Anchorage terminal, but not including the latter; the trunk line from Haynesville gate plant to Moore station; the trunk line from the Texas state line to Moore station, and the main line construction and maintenance supervisors.



Hugh L. Hamilton

Hugh L. Hamilton has been named to manage and direct activities of the A. V. Smith Engineering Company, 370 Trevor Lane, Bala-Cynwyd, Pennsylvania. The company will continue to conduct field surveys and studies leading to recommendations for the control of corrosion.

Hamilton has been associated with The Atlantic Refining Company subsidiaries, Keystone Pipe Line Company and Buffalo Pipe Line Corporation, for the last 15 years. In this work he was responsible for the pipe lines' corrosion control program, also acting in an advisory capacity to the various Atlantic Refining Company departments and other subsidiaries.

Hamilton, a professional engineer in Pennsylvania, is a member of the American Institute of Electrical Engineers, and an officer of the National Association of Corrosion Engineers.

Dr. Mars G. Fontana, Ohio State University, addressed the North Texas Section of the National Association of Corrosion Engineers at Fort Worth on September 21. His subject was "New Developments in Corrosion Resistant Alloys". Fontana is a vice president of NACE.

Wilbert O. Crain, former Houston attorney, has been appointed general counsel of United Gas Corporation, United Gas Pipe Line Company, and Union Producing Company.

N. C. McGowen, president, announced the appointment at the firm's headquarters in Shreveport, Louisiana, stating at the same time that **George D. Fiser,** formerly general counsel, had been named advisory attorney.

Saunders Gregg, also a former Houston attorney with the firm of Vinson, Elkins and Weems, has been made assistant to the general counsel in handling contract matters.

M. L. Powers, director of the Division of Engineering and Industrial Extension at Oklahoma A. and M. College spoke on management problems before the September 17 meeting of The Pipe Liners Club of Tulsa. He emphasized particularly (1) the free enterprise system, (2) the relationship of management to various groups of interest, (3) the responsibility of management, and (4) just who is management?

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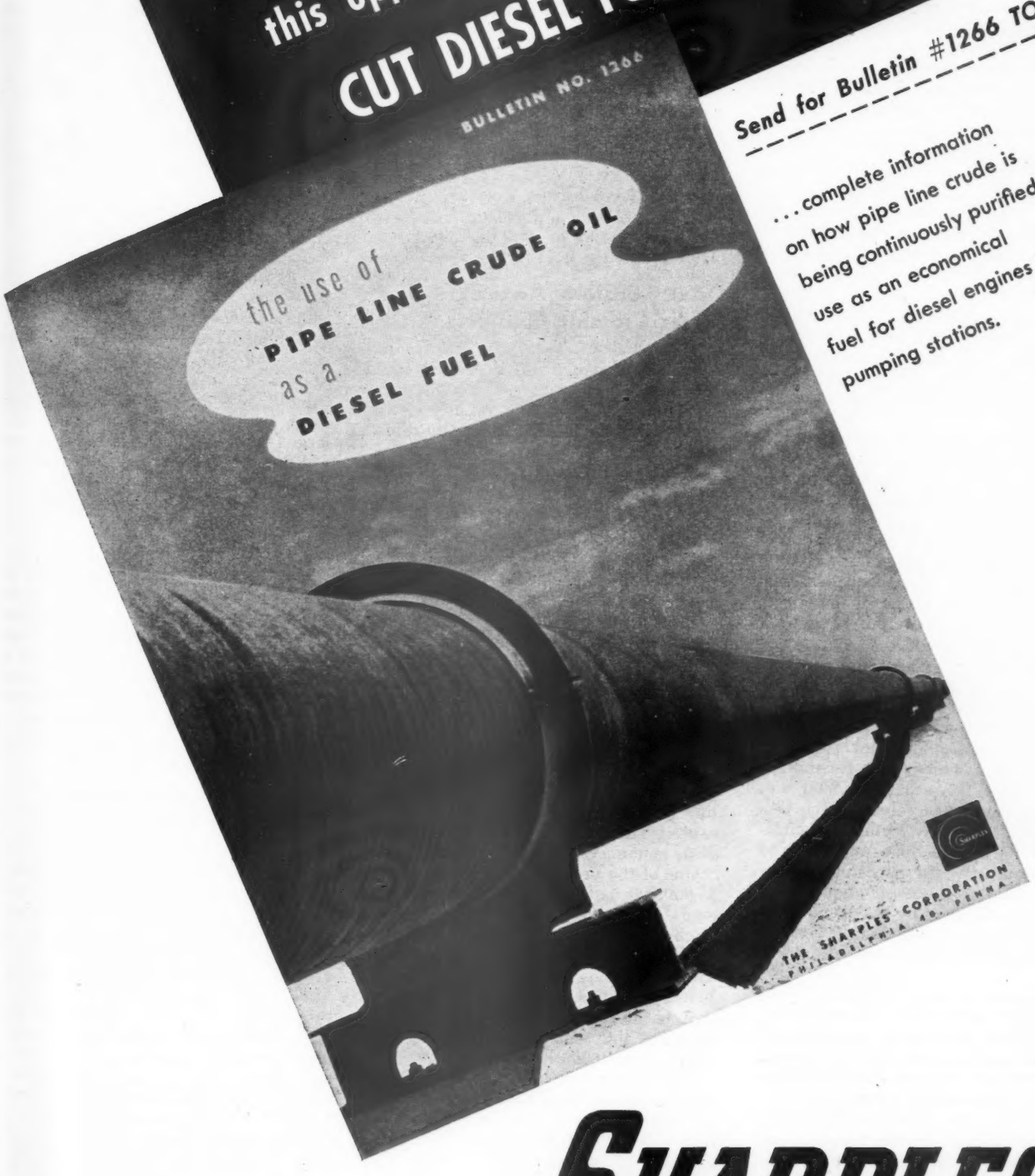

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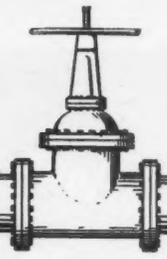
PIPE LINE PROJECTS



FPC Modifies Order Involving Tennessee Gas

The Federal Power Commission has modified its order of June 1, relating to the authorization of the construction of additonal natural gas pipe line facilities by Tennessee Gas Transmission Company, of Houston, Texas, by eliminating conditions imposed on Tennessee's sales to three companies.

The FPC's action followed a rehearing held at the request of Tennessee. The commission, however, again denied authority for Tennessee to construct its proposed line from the Hebron field in Potter County, Pennsylvania, to a connection with the company's main line in Utica, New York.

The commission's June 1 order authorized Tennessee to carry out an expansion program designed to increase the daily design delivery capacity of its system from 1,310,000,000 cu ft to approximately 1,395,000,000 cu ft.

That order denied the proposed 162-mile Hebron-Utica line, among other facilities, on the grounds that a finding could not be made at that time that the public convenience and necessity required the construction and operation of facilities north and east of the Hebron storage area, since no evidence was submitted as to whom this gas is to be sold, where it is to be delivered, or in what volumes it will be sold.

The June 1 order also imposed conditions on Tennessee's deliveries and sales to United Natural Gas Company, of Oil City, Pennsylvania, Iroquois Gas Corporation, of Buffalo, New York, and Equitable Gas Company, of Pittsburgh, Pennsylvania. The order provided that these sales would be subject to curtailment in the event any of the gas scheduled for delivery to them was required for development and operation of the Hebron field. Tennessee and United have been authorized by the commission to jointly develop and utilize the Hebron field for underground storage of natural gas.

In rescinding these conditions, the commission authorized Tennessee to make available to United, Iroquois, and Equitable a maximum daily volume of 15,000,000 cu ft each on a firm basis as originally proposed by Tennessee.

The commission based its action, in the case of United, on the fact that the deliveries should be made to that company to enable it to share equitably in the storage pool project. With respect to the other two companies, the FPC said that they should receive the 15,000,000 cu ft a day on a firm basis in order to assure them much needed supplies of gas.

In upholding its denial of the Hebron-Utica line, the commission said that "in the absence of proper factual information as to what markets will be served with gas from the Hebron storage field, it is inappropriate to determine, at this time, whether the . . . line, as presently proposed, is the proper facility required to deliver the gas out of the storage area into Tennessee's system."

Commissioner Thomas C. Buchanan, who concurred in part and dissented in part, said: "I concur in the action of the majority in granting to United Natural, Iroquois and Equitable a firm supply of gas as applied for. I disagree in their denial of the line from the Hebron storage field to Utica, N. Y."

Texas Eastern Awards River Crossing Contracts

Texas Eastern Transmission Corporation has awarded to Pentzien, Inc., Omaha, Nebraska, a contract for construction of a pipe line crossing of the Ohio River on the Kentucky-Ohio border.

Williams Brothers Company of Tulsa, Oklahoma, has been awarded a contract for a pipe line crossing of the Ohio River on the Ohio-West Virginia border.

Both river crossings are part of Texas Eastern's current construction of 791 miles of 30-in. pipe line from Kosciusko, Mississippi, to Connellsville, Pennsylvania.

PAD Approves Two Lines by Continental

Continental Pipe Line Company has received approval from the Petroleum Administration for Defense for two pipe line projects aggregating an expenditure of $7,900,000, W. L. Kugar, president, announces.

One of the projects, scheduled to cost $5,900,000, is a 12-in. line that will extend approximately 225 miles from Wichita Falls, to Ponca City, Oklahoma, carrying crude from Montague, Clay, Throckmorton, Archer, Wichita, and Young counties in the Wichita Falls area, to the company's refinery at Ponca City. The line will have an initial daily capacity of 40,000 bbl.

The other project is an 8-in. 100-mile line extending from the Rincon Field, in Starr County, in the southern tip of Texas, by way of McAllen to Port Isabel, near the mouth of the Rio Grande River. This line, costing $2,000,000, will have a capacity of 17,000 bbl a day and will move crude oil from the Rincon area to Port Isabel. In addition, stabilized distillate from a cycling plant near McAllen and crude oil from the McAllen area will be carried to Port Isabel for Taylor-Mayfair Company.

Construction Begins on Sarnia-Toronto Line

Construction of the 64-mile Sarnia to London section of the Sarnia-Toronto pipe line has begun and should be completed by December, Imperial Oil Limited, Toronto, announces. The London-Toronto sections and spur line to Hamilton will be built next spring.

The contract for the construction has been awarded to Comstock Midwestern, Ltd., of Leaside, Ontario. The Sarnia to Waterdown section, 132 miles, will be 12-in. pipe, the 56-mile Waterdown-Toronto section, 10-in., and the Hamilton spur will consist of two 6-in. lines.

The line will have an initial capacity of 39,000 bbl a day of gasoline, kerosine, and heating oils.

Although transportation costs by the pipe line will be approximately the same as for tankers, there will be a considerable saving in steel because fewer ships will be required and additional large tankage will not be needed to store supplies for the winter season, the company states.

Service Asks Bids On West Texas Line

Service Pipe Line Company has requested bids from contractors for the construction of approximately 30 miles of 6-in. pipe line to connect the South Haskell and North Knox City pools in West Texas, C. M. Scott, Tulsa, general manager, has made known. Production from the two pools will be pumped into the company's Jud-Bowie trunk line, now under construction.

United Fuel Authorized To Expand Facilities

The Federal Power Commission has authorized United Fuel Gas Company, of Charleston, West Virginia, to construct pipe line facilities in Putnam and Kanawha Counties, West Virginia, in order to expand the company's underground natural gas storage operations.

The new facilities will include approximately 45 miles of natural gas transmission line, and a 2640-hp compressor station together with dehydration plant, auxiliary units, and appurtenant equipment near Lanham, West Virginia. In addition, the company will transfer one 1000-hp gas engine unit from its Walgrove compressor station to its Kanawha compressor station.

Estimated total overall capital cost of the project is $4,755,830.

United now has 10 storage pools in depleted gas fields near its transmission lines and markets, and plans to acquire and activate three additional pools in Putnam and Kanawha counties.

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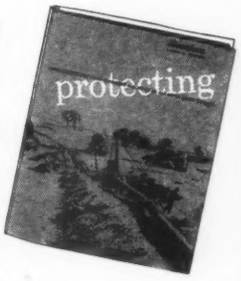

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Columbia Subsidiaries To Lay New Pipe Lines

The Federal Power Commission has authorized three subsidiaries of The Columbia Gas System, Inc., to carry out the construction of new natural gas transmission facilities in Kentucky, Ohio, and West Virginia.

The companies involved are The Ohio Fuel Gas Company, of Columbus, Ohio; Central Kentucky Natural Gas Company, of Charleston, West Virginia, and Atlantic Seaboard Corporation, also of Charleston.

Central Kentucky had two applications pending before the commission, one of which was denied. It involved the proposed construction of about 13 miles of line to carry additional gas to customers in the Cincinnati, Ohio, market area. The FPC said that in its view the record does not show that Central Kentucky has sufficient gas available to deliver the required volumes to the Cincinnati area, and that the installation of these facilities may encourage an unwarranted load growth in that area beyond the company's ability to serve.

The other Central Kentucky project, which was authorized, includes the construction of 18.6 miles of line to supply additional gas in the company's Southern Division (a system of lines extending generally from Inez to Lexington, Kentucky). These facilities, estimated to cost $700,000, will increase by about 20,210,000 cu ft a day the present capacity of the existing system serving the Southern Division.

Ohio Fuel was authorized to build about 61 miles of line in northern and southwestern Ohio to help meet increased demands and future growth in the Sandusky, Elyria, and Dayton market areas. Estimated cost of these facilities is $2,690,000.

Atlantic Seaboard will construct a 3520-hp compressor station in Randolph County, West Virginia, on its Cobb (W. Va.)-Rockville (Md.) line at an estimated cost of $1,350,000. The compressor station will increase the capacity of the Cobb-Rockville line by about 32,300,000 cu ft a day, for use in the Baltimore, Maryland, and Washington, D. C., area and markets served by the Commonwealth Natural Gas Corporation.

Northern Natural Hearing Continued to October 22

The Federal Power Commission hearing in the proceeding involving Northern Natural Gas Company's application for authority to expand its natural gas transmission system has been continued from September 17 to October 22 in Washington, D. C.

The action was taken upon consideration of a motion filed by the company, which has its main office in Omaha, Nebraska.

Illinois Storage Project Proposed

Natural Gas Storage Company of Illinois, of Chicago, Illinois, is seeking Federal Power Commission authorization for the development of a multimillion dollar underground storage area, for natural gas in Kankakee and Iroquois counties, Illinois.

The project, with an ultimate estimated cost of $36,200,000 would be used to store natural gas for Natural Gas Pipeline Company of America and Texas Illinois Natural Gas Pipeline Company. The three companies are affiliated.

The application says that present studies indicate that the proposed storage project, when fully developed, would provide a useful storage capacity of 90 billion cu ft of gas, with a maximum withdrawal of 1½ billion cu ft a day.

The company plans initially to drill 25 wells, with an estimated maximum of 50 wells as the project develops. The proposed project also includes initially about 6½ miles of pipe lines, with a total of 12¼ miles to be built ultimately, and a compressor station with an initial capacity of 6000 hp and an ultimate capacity of 32,000 hp.

The company plans to begin the project by July, 1952, and to complete it for initial operation within a year. The application says the project would be progressively enlarged as materials become available and the demand for gas in the area served by Natural and Texas Illinois may require. Initial cost of the project is estimated at $18,100,000.

Service Will Lay Two Short Oil Lines

Contracts have been awarded Texas contractors to lay 6-in. pipe lines connecting two West Texas oil pools with Service Pipe Line Company's Jud-Bowie trunk line now nearing completion, C. M. Scott, Tulsa, general manager, announces.

Jim J. McCormick Company, Wichita Falls, Texas, will lay 15 miles to connect the North Knox City pool, and Gaasch Construction Company, Brownfield, Texas, will lay 15 miles to connect the South Haskell pool.

Scott said the completed portion of Service Pipe Line's Jud-Bowie line was being hydrostaticly tested this week. The 123-mile line was approximately 90 per cent completed.

Chicago District Asks Permit for Short Line

Chicago District Pipeline Company, of Joliet, Illinois, has applied to the Federal Power Commission for authority to construct a 15-mile, 30-in. pipe line in Cook County, Illinois, for the transportation of natural gas for the account of Public Service Company of Northern Illinois.

The gas will be delivered to Chicago District at the western terminus of the proposed 15-mile line by the Texas Illinois Natural Gas Pipeline Company. The line, estimated to cost $1,650,000 would extend from the connection with the Texas Illinois system near Elgin, Illinois, 15 miles east to a connection with Public Service's system.

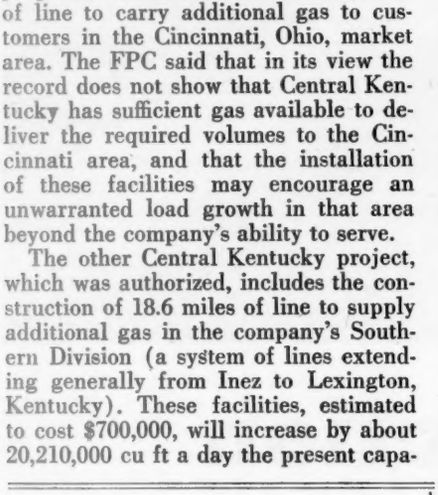
The proposed new line would have a capacity of approximately 426,000,000 cu ft of gas a day, the application says, but until additional supplies of gas are available deliveries will range between 35,000,000 and 66,000,000 cu ft.

Contract Awarded For Pipe Reconditioning

Service Pipe Line Company has awarded contract to C. L. Rogers Construction Company of Wichita Falls, Texas, to take up and recondition approximately 23 miles of 10-in. pipe in Platte County, Wyoming, that comprised a part of the company's Wyoming-Missouri trunk line, General Manager C. M. Scott announces.

The loop was no longer required as larger pipe was installed in this section of the system some time ago. After it is reconditioned at Cassa, Wyoming, the pipe will be shipped to Texas where it will be re-used in the construction of a line between Wasson and Denton.

Construction is well past the half-way mark on Service's 123-mile 10-in. pipe extension to its system from Bowie, Texas, to the Old Glory area in West Central Texas. Smith Construction Corporation, Fort Worth, is building 57.3 miles from the Brazos River to Jud, and O. R. Burden Construction Company, Tulsa and Wichita Falls, 65.7 miles from the Brazos to Bowie, including the Brazos River crossing.



Gas Line and Compressor Station Construction Asked

Cumberland and Allegheny Gas Company and The Manufacturers Light and Heat Company, both subsidiaries of The Columbia Gas System, Inc., with main offices in Pittsburgh, Pennsylvania, have asked the Federal Power Commission for authority to build natural gas pipe line facilities in Maryland, Pennsylvania, and West Virginia, to help obtain the greatest possible production from gas fields in Maryland and West Virginia.

Cumberland is proposing to construct a total of about 46 miles of new line, to install 2080 hp at two new compressor stations, and to convert an existing station to two-stage operation. Manufacturers wants authorization to build about 100 ft of gas line and to exchange a compressor cylinder at one of its stations for a similar cylinder at one of Cumberland's stations.

Total estimated net cost of the construction is $2,191,237, or $2,180,137 for Cumberland and $11,100 for Manufacturers.

Cumberland's proposed construction program includes a 35-mile 10-in. line from the Mountain Lake Park, Maryland, area, to a connection with Manufacturers' system on the Pennsylvania-West Virginia State Line in Monongalia County, West Virginia. The remaining 11 miles of line would be located in various sections of Garrett County, Maryland, and Preston County, West Virginia. An 800-hp compressor station would be built in Garrett County, Maryland, as well as a 1200-hp station, and a 1200-hp unit would be situated in Preston County, West Virginia. The compressor station to be converted is in Lewis County. The joint application is for improving production.

FPC Authorizes Compressor Station, 35-Mile Gas Line

The Federal Power Commission has authorized New York State Natural Gas Corporation, of New York City, to construct a 6600-hp compressor station in the town of Dryden, New York, and 35.2 miles of 20-in. loop line extending northward from the proposed station to the company's Therm City compressor station.

Purpose of the facilities is to assure the delivery of adequate supplies of natural gas to meet estimated future requirements of customers in the Therm City, Auburn, and Albany areas. These customers include Niagara Mohawk Power Corporation, which distributes gas in Syracuse, Albany, and Utica, and New York State Electric and Gas Corporation, whose distribution area includes Auburn, Ithaca, and Cortland.

New York State Natural plans to install 3300 hp at the proposed new station in 1951; 1100 hp in 1952, and the remaining 2200 hp in 1953. The 35.2-mile loop line is to be built in 1953.

Total overall capital cost of the project is estimated to be $3,620,533.

East Tennessee Natural To Add to Facilities

The Federal Power Commission has authorized East Tennessee Natural Gas Company, of Knoxville, Tennessee, to deliver additional natural gas to the Atomic Energy Commission's Oak Ridge, Tennessee, plant and to construct pipe line facilities to serve three towns in Tennessee.

The order authorizes East Tennessee to sell additional volumes of gas not to exceed 16,900,000 cu ft a day to the AEC until June 30, 1952, and after that date, on an interruptible basis, gas in such volumes as required by the AEC and as East Tennessee is willing and able to deliver. East Tennessee previously was authorized to sell up to 60,000,000 cu ft a day to the AEC.

To serve the three Tennessee towns, East Tennessee will build three lateral pipe lines totaling about 8 miles in length, together with physical connections, metering measuring and regulating equipment. Gas transported through these facilities will be sold and delivered to Cookeville, Gallatin, and Harriman, for resale in those cities.

Estimated cost is $105,000.

In a separate order, the Commission authorized Tennessee Gas Transmission Company, of Houston, Texas, to supply the additional gas to East Tennessee for the newly authorized service.

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Williamson Pipe Line Pigs*

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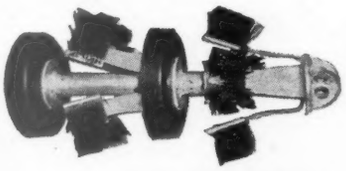
NATURAL GAS PIPE LINES

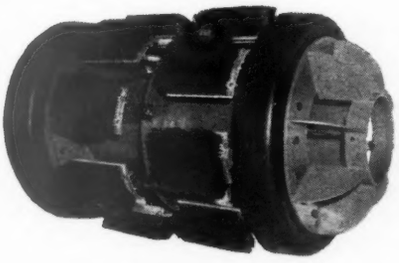
4" Size—TYPE JRN—2" to 4" sizes will pass 1½ R-90° Bends. No valves other than full diameter thru port valves.

Use TYPE SCN-51 for 6" size.



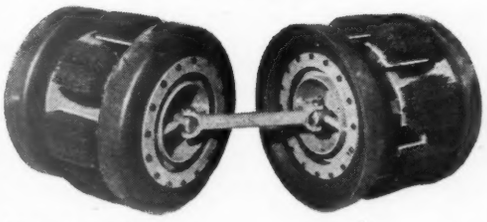
8" Size—TYPE WC-11—8" to 14" will traverse 6 foot radius field bends, full diameter side openings at 45°.

SPRINGS COMPENSATE for BRUSH WEAR.



20" Size—TYPE GP-2—16" to 30" 200 lb. SPRING forces the brushes against pipe wall—COMPENSATING for WEAR. Will traverse round opening gate or plug valves.

SPRINGS and BRUSHES are identical and interchangeable for all types and sizes of GP-PIGS.



24" Size—GP-3—18" to 30" sizes will pass 1½ R-30° bends. SPRINGS COMPENSATE for BRUSH WEAR ASSURING full section cleaning efficiency. GP-3 consists of two Type GP-1 Pigs. Each unit may be used as individual pig.

*Patents Pending

T. D. Williamson, Inc.

TULSA 9, OKLAHOMA

With the PIPE LINE CONTRACTORS

Houston Contracting Company, 2707 Ferndale Place, Houston, Texas, has the following construction work under contract:

Approximately 181 miles of 26-in. gas line for Texas Gas Transmission Corporation from the vicinity of Bastrop, Louisiana, South to the vicinity of Eunice, Louisiana. This work is being done by three spreads as follows:

North spread starting near Beekman, Louisiana, and laying approximately 65 miles South to the vicinity of Grayson, Louisiana. W. H. Hayes, superintendent; M. L. Thompson, assistant superintendent; J. C. Strickler and J. B. Stoddard, office; headquarters, Monroe, Louisiana.

Center spread starting at header on the north side of the Red River near Pineville, Louisiana, and laying approximately 60 miles north to the vicinity of Grayson, Louisiana. E. C. Norris, superintendent; R. E. Thornton, assistant superintendent; R. J. Axsom, office; headquarters, Kingsville (Pineville), Louisiana. Started laying pipe September 12.

South spread starting at header on south side of the Red River and laying approximately 56 miles south to Tepetate field near Eunice, Louisiana. F. A. Silar, superintendent; C. V. Oliver, assistant superintendent; L. F. Redfearn, office; headquarters, Bunkie, Louisiana. Started laying pipe September 20.

Approximately 140 miles of 12-in., 8-in., and 6-in. lay and take up for Interstate Oil Pipe Line Company in the vicinity of New Iberia and Franklin, Louisiana. H. L. Leake, superintendent; S. B. Harrison, assistant superintendent; H. C. MacWhinnie, office; headquarters, New Iberia, Louisiana.

Anderson Brothers Corporation, 707 North Drennan Street, Houston, Texas, has recently contracted to lay 90 miles of 14-in. for Gulf Oil Corporation between Lumberton, Mississippi, and Mobile, Alabama. A field office has been opened at Lumberton with Dick Leonard the superintendent.

Other jobs by this contractor are as follows:

For Michigan Consolidated Gas Company, 121 miles of 24-in. from Big Rapid to Farmington, Michigan. Two spreads are at work. J. F. Whitlow is superintendent of the spread working out of Clare, and Lewis Knox is in charge at Owasso.

Tennessee Gas Transmission Company, 68 miles of 30-in. from Horse Cave, Kentucky, to Campbellsville; nearing completion. Field office is at Glasgow, with E. E. McCoy superintendent.

Tennessee Gas Transmission Company, 90 miles of 30-in. from Drew to Holly Springs, Mississippi. Field office is now at Drew. Earl Saulsman is superintendent.

Algonquin Gas Transmission Company, 100 miles of 24-in. from Hartford, Connecticut, to Boston, Massachusetts. One field office is at Glastonbury, Connecticut. Ray Bendure is superintendent, C. L. Franklin assistant superintendent, and Frank Hindman office manager. A second spread has its office at Mendon, Massachusetts. "Rusty" Killingsworth is superintendent, and Russell McDowell office manager.

Good progress is being made on the Triangle Pipe Line Company project, 85 miles of 10-in. products pipe line from El Dorado to Arkansas City, Arkansas. One spread is working out of Dermott. "Red" Williams is superintendent and Hugh Higginbotham office manager. A second spread has its field headquarters at Warren. Here Dick Plake is superintendent and Mike Keady office manager.

Pan American Gas Company, 40 miles of 16-in. from Texas City to Winnie, Texas. Field office is at Anahuac with D. C. Pope the superintendent.

H. C. Price Company, Pipeline Division, Box 1111, Bartlesville, Oklahoma, is now overhauling equipment at following spread locations while awaiting resumption of construction activities:

Auburn, New York: G. A. Reutzel, superintendent; W. E. Yount, office manager; J. A. Hairston, right-of-way foreman; L. J. Loncarich, ditch; J. C. Anderson, bending; H. C. Morrison, pipe; K. N. Adkins, pipe; R. W. Orr, welding; S. J. Wood, coating; A. L. Bell, lower-in; T. E. Walker, clean-up; and J. H. Ingram, Sr., chief mechanic.

Warsaw, New York: R. K. Shivel, superintendent; W. R. Crego, office manager; J. D. White, right-of-way foreman; W. H. Olrich, ditch; J. H. Latham, bending; Delbert Shivel, pipe; R. L. Ezell, welding; J. B. Northcutt, coating; C. W. Sisco, lower-in; Sam Price, clean-up; Cleo Robertson, road crossing, and Tommie Stammer, chief mechanic.

Atlanta, Texas: C. E. Shivel, superintendent; D. H. Johnston, office manager; C. F. Jones and R. H. Edwards, right-of-way foremen; Ray Drewell, ditch; J. V. Huff, bending; John Stokes, welding; Henry Hill, coating; Bill Buchanan, lower-in; Paul McCormack, clean-up, and Boyd Danner, chief mechanic.

Goodrich, Texas: C. R. Ice, superintendent; G. A. Harvey, office manager; W. O. Elliott and Jessie Cash, right-of-way foremen; E. W. Whisenant, ditch; Forest Loinette, bending; W. T. Dickerson, pipe; L. O. Reutzel, welding; N. D. Adams, coating; J. C. Rich, lower-in; John E. Hamilton, clean-up, and Cliff Birmingham, chief mechanic.

Britton Contracting Company, Inc., 93 South Main Street, Washington, Pennsylvania, began work in September on 20 miles of 20-in. for Home Gas Company, from Quackenbush to Horseheads, New York. The field office is at the latter point with Frank Hart superintendent. For the same company, 17 miles of 12-in. are being laid between Hancock to a point near Deposit, New York. The field office is at Deposit. "Lucky" Blackmon is superintendent. J. F. Hahn is general superintendent over both spreads.

For Manufacturer's Light and Heat Company, 96 miles of pipe is being laid in Pennsylvania. A spread in charge of L. A. Stewart is laying 76 miles of 16-in. from Cherokee to a point near Pittsburgh. Headquarters are at Indiana, Pennsylvania. A second spread, under the supervision of Fred McKenzie, is laying 20 miles of 24-in. from the Monongahela River to Rickory. The field office is at Finleyville.

N. A. Saigh Company, Inc., Suite 531 Majestic Building, San Antonio 5, Texas, has underway 80 miles of 30-in. for Texas Eastern Transmission Corporation, from Columbia to Boonsboro, Kentucky. The field office is at 109 North Central Avenue, Campbellsville, Kentucky. Telephone: 373. Carl Doyle is superintendent, Hubert Hutchins and Raymond Doyle assistant superintendents, James E. Gray office manager, Jesse Cobb chief inspector. Foremen are: Carl Avrett, welders; J. N. Childress, dope; H. N. Russell, right-of-way; W. B. Uehling, stringing, and Charley Warren, pipe. James R. Scott is materials man.

Dunn Brothers, 801 Mercantile Securities Building, Dallas, Texas, (stringing contractors) have the following jobs under contract:

Texas Illinois Natural Gas Pipeline Company, Section 5, 91 miles of 30-in. from Urbana to Dotson, Texas, and Section 6, 99 miles from Dotson to the Texas-Arkansas state line.

El Paso Natural Gas Company, 415 miles of 24-in. in New Mexico and Arizona on the San Juan line.

El Paso Natural Gas Company, 419 miles of 30-in. in New Mexico, Texas, and Arizona.

Northeastern Gas Transmission Company, 65 miles of 16-in. in Connecticut and Massachusetts.

Tennessee Gas Transmission Company, 95 miles of 30-in. from Drew to Holly Springs, Mississippi.

Tennessee Gas Transmission Company, 60 miles of 30-in. from Colesburg to Dickson, Tennessee.

Tennessee Gas Transmission Company, 60 miles of 30-in. from Salt Lick to Richmond, Kentucky.

Oklahoma Contracting Company, 6512 Hines Boulevard, Dallas, Texas, has completed all main line work for Northeastern Gas Transmission Company and will wind up the laterals about October 15. The overall contract covered 175 miles of 24-in. main line from a point near Albany, New York, to Wilmington, Massachusetts, and 110 miles of laterals ranging in sizes from 3 in. through 12 in. The various spreads that were working on the main line are now concentrating on the laterals in an effort to get them in before cold weather. Superintendents include H. A. "Red" Wiley, M. E. "Panama" Shifflet, J. E. "Ed" Flanagan, and Louis Visentine. Central headquarters are at Framingham, Massachusetts, with W. H. Law in charge.

A crossing is being installed under the Tennessee River at Florence, Alabama, for Brown and Root, Inc., on the Texas Eastern Transmission Corporation system. Officials in charge are Paul Halbert, Aldress Kilgore, and Harry Prindle.

Brown-Lite Company, 135 North Sheridan, Tulsa, Oklahoma, began laying pipe in September on 101 miles of 8-in. for Phillips Petroleum Company. This is a products line. The section is from East St. Louis to Chicago, Illinois. The field office is at Taylorville. Bob Carriker is superintendent.

Midwestern Constructors, Inc., 105 North Boulder, Tulsa 3, Oklahoma, is about to complete its work on the Texas Illinois Natural Gas Pipeline Company system. By the middle of September, 98 per cent of the 100 miles of 30-in. pipe between Chester and Effingham, Illinois, was in the ground. Two spreads are pushing this work. The one at DuQuoin is in charge of Mac Hoffman, and the one at Vandalia under the supervision of John Work.

Schedule 12, 100 miles of 30-in. from Effingham to Sibley, Illinois, was 85 per cent completed.

Schedule 13, 92 miles of 30-in. from Sibley to Joliet, was 98 per cent completed. The field office is at Monticello with Denver Franklin the superintendent.

The crossing of the Mississippi River near Wittenburg, Missouri, was about 40 per cent completed. Three 20-in. lines are being installed. The field office is at Grand Tower, Illinois. Howard S. Lipp is coordinator, Friday Davis superintendent in charge of pipe, and Ivan Steele office manager.

The central office for the Texas Illinois work is at Decatur, Illinois. M. T. Wilhite is general superintendent and A. T. Tolbert is looking after the office.

The original station work for Panhandle Eastern Pipe Line Company has been completed. One additional unit is being installed at Tuscola, Illinois, however, and two units at Edgerton, Indiana. At the former, F. C. Snavely is superintendent and Morris D. Garey office manager. At the latter, Earl S. Powell is superintendent and H. H. Voss office manager. This work is 30 per cent completed.

At Bauxite, Arkansas, 10,000 ft of 8-in. cast-iron pipe was completed recently, and another job involving 8800 ft begun. The latter is now 75 per cent finished. W. L. Daniels is superintendent and John Hoff engineer.

Brown and Root, Inc., P. O. Box 3, Houston, Texas, has a contract with United Gas Pipe Line Company covering various phases of engineering, construction, and other services on more than 1000 miles of pipe line in Texas, Louisiana, and Mississippi.

Bishop and Lock Construction Company, 1018 Magnolia Building, Dallas, Texas, continues to play a waiting game on the Platte Pipe Line Company job—no pipe. It will probably be sometime this winter before pipe is available. This contractor will lay 142 miles from Marysville, Kansas, to Holdrege, Nebraska.

Smith Contracting Corporation, 205 Northwest Seventh Street, Fort Worth, Texas, has completed 57 miles of 10-in. for Service Pipe Line Company from the Salt Fork of the Brazos River near Throckmorton, Texas, to Humble's Jud station near Haskell. The field office was at Haskell, with Herb Smith superintendent, Jim McKnight spreadman, and John Briggs office manager.

Pentzien, Inc., Omaha, Nebraska, has contracted to lay a pipe line across the Ohio River for Texas Eastern Transmission Corporation. The installation will be on the Kentucky-Ohio border.

H. L. Gentry Construction Company, 921 East Michigan Avenue, Jackson, Michigan, is installing pipe lines for the Ohio Fuel Gas Company in the cities of Toledo, Fostoria, and Parma. Newton Dukes and Bob Cantrell are spreadmen at Toledo. At Fostoria, Milo Larsen is superintendent, and at Parma, A. J. Brown.

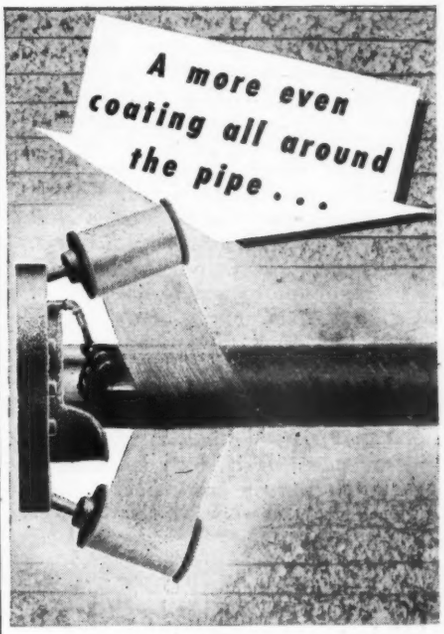
For United Fuel Gas Company, 32 miles of 20-in. are being laid near Charleston, West Virginia. Work began in August.

Thirteen miles of 16-in. pipe are being laid for Equitable Gas Company of Pittsburgh, Pennsylvania. This includes a crossing of the Ohio River. Lavern Curtis and Frank Morris are in charge.

James G. Mitchell is general superintendent over all work.

Cheek Construction Company, P. O. Box 491, Ulysses, Kansas, is installing a gathering system for Cities Service Gas Company near Ulysses in the Hugoton gas field. In all, 101 miles of pipe will be laid, 6-in. through 22-in.

Western Pipe Coating Company, Inc., P. O. Box 181, Iola, Kansas, is coating 65 miles of 10-in. pipe for O. R. Burden Construction Corporation. The pipe is being used between the Brazos River and Bowie, Texas, in the Service Pipe Line Company's system.



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Associated Pipe Line Contractors, Inc., 3272 Westheimer Road, Houston, Texas, has completed 188 miles of 6⅝-in. pipe line for the U. S. Corps of Engineers, from Searsport to Limestone, Maine. Work is progressing on the Mississippi River crossing for Mid-Valley Pipeline Company near Rolling Fork, Mississippi. The field office is at that point with Wm. Briley superintendent and R. N. Cain office manager.

A total of approximately 100 miles of 20, 24, and 26-in. pipe is being laid for United Gas Pipe Line Company, extending from Napoleonville, Louisiana, to the Gulf of Mexico in the New Orleans area. The field office is at Morgan City. J. A. Williamson is general superintendent, L. H. Gray spreadman, and Ralph Herwig and James Luther in the office. The work is being done in conjunction with J. Ray McDermott and Company.

For Southern Natural Gas Company, 40 miles of 24-in. double loop line are being laid in Louisiana and Mississippi. The field office is at Rolling Fork and the same supervisors are handling this job as for the river crossing.

Conyes Construction Corporation, 2884 San Pablo Avenue, San Pablo, California, has contracted 117 miles of 22-in. pipe line from Ohio Oil Company. The line will be laid from Sheridan to Lima, Ohio. Jimmy Allman and Morris Norwood will be the spreadmen.

Somerville Construction Company, Ada, Michigan, expects to begin about October 1 on construction of 48 miles of 8-in. for Phillips Petroleum Company from Farmer City to Pipe City, Illinois. This work will be in charge of Harold Cook, working out of Gibson City, Illinois. A second spread will begin work about the same time on a 25-mile 8-in. section from Beecher, Illinois, to East Chicago, Indiana.

Williams Brothers Company, National Bank of Tulsa Building, Tulsa, Oklahoma, now has its field offices at Gastonia, North Carolina, and Greenville, South Carolina, on the Plantation Pipe Line Company job. T. E. Davis is superintendent of the Greenville spread and J. E. G. Jester office manager. At Gastonia, A. T. Maxwell is superintendent and J. E. Breedlove office manager. Overall, the Plantation job consisted of 712 miles of 14 and 18-in. pipe from Baton Rouge, Louisiana, to Charlotte, North Carolina, paralleling the present system. George Allen is general superintendent.

From South Bend, Pennsylvania, to Petersburg, on the Pennsylvania-Ohio state line, 78 miles of 20-in. are being laid for the New York State Natural Gas Corporation. The field office is now at Mars, Pennsylvania. Clyde Gregory is superintendent and Walter B. Hammond office manager.

For East Ohio Gas Company, 65 miles of 26-in. are being laid between Cleveland and Petersburg. R. R. Mitchell is superintendent and J. R. Purdy manager of the field office, which is at Ravenna.

Recently a contract was entered into with Texas Eastern Transmission Corporation to install a crossing of the Ohio River on the Ohio-West Virginia border.

Work is going ahead now on the Shell Caribbean Petroleum Corporation line in Venezuela. This pipe line system will consist of 160 miles of 30-in., extending from Palmerejo, near Maracaibo, to Punta Cardon, Venezuela. The project is under the supervision of Marvin Jones, who has his office in Caracas.

Jones also is in charge of the Venezuelan Atlantic Transmission Corporation line between Las Mercedes and Caracas. This project consists of 195 miles of 10, 12, and 16-in. pipe line.

Fulton and Brodie, Hugoton, Kansas, is laying 123 miles of 16, 20, 24, and 26-in. pipe for Northern Natural Gas Company, from a point north of Ulysses, Kansas, to a point near Guymon, Oklahoma. The operating office is at Hugoton, Kansas, E. H. Marley is superintendent.

Rumsey Brothers Pipe Line Construction Company, M. and M. Building, Houston, Texas, hopes to get pipe sometime this winter to begin construction work on its section of the Platte Pipe Line Company system. This contractor will lay the line from the Nebraska-Kansas state line near Lanham, Kansas, to the Missouri River near Doniphan, Missouri.

L. E. Farley, Inc., 516 Chronicle Building, Houston, Texas, is laying 64 miles of 10-in. pipe for Gulf Refining Company between Eucutta and Lumberton, Mississippi. The field office is at Laurel with Glen Allman the superintendent and Wallace Campbell office manager.

River Construction Corporation, P. O. Box 9127, Fort Worth, Texas, is now underway on the East Section of United Gas Pipe Line Company's expansion work. Between Napoleonville Junction and Kosciusko, Mississippi, 212 miles of 20-in. and 43 miles of 24-in. will be laid. "Red" Tatom's spread began laying pipe September 18. This is 55 miles of 30-in. from the Mississippi River to the Louisiana-Mississippi state line. The field office is at Donaldsonville, Louisiana, and A. L. Price is office manager.

Jim Reid's spread began laying pipe September 25, the section being between Baxterville and McComb, Mississippi, and consisting of 43 miles of 24-in. Field headquarters are a Columbia, Mississippi.

By October 5 a spread under Merle Tatom should get underway. This spread will lay 40 miles of 30-in. from McComb to Livingston.

Two river crossings are under construction. Two 20-in. lines across the Pearl River were 75 per cent completed September 17. Three 20-in. lines across the Amite River were 50 per cent completed.

H. C. Price Company, Somastic Division, Box 1111, Bartlesville, Oklahoma, has the following jobs under way:

East Coast Division (at Bustleton, Pennsylvania):

Consolidated Edison Company—Application of Somastic coating and internal cleaning and coating to approximately 13,400 ft of 8⅝-in. O D pipe and application of 2-in. Hevicote; application of Somastic coating and internal cleaning and coating to approximately 16,800 ft of 8⅝-in. O D pipe.

Phelps-Dodge Corporation—Application of Somastic coating and internal cleaning and coating to 7800 ft of 8⅝-in. O D pipe.

Philadelphia Electric Company—Application of Somastic coating to 500 ft of 20-in. O D pipe; 80,000 ft of 16-in. O D pipe; 3200 ft of 8⅝-in. O D pipe, and 3200 ft of 4½-in. O D pipe.

Philadelphia Gas Works Company—Application of Somastic coating to all pipe requirements from 1¼-in. to 30-in. for 1951.

At Staten Island New York:

Transcontinental Gas Pipe Line Corporation—Application of 1½-in. Hevicote over Somastic to 9400 ft of 26-in. O D pipe; application of 3-in. Hevicote over Somastic to 8100 ft of 24-in. O D pipe.

Gulf Coast Division (at Morgan City, Louisiana):

Gulf Southern Contractors (for United Gas Pipe Line Company)—Application of Somastic coating to approximately 26.3 miles of 30-in. O D pipe; 22.8 miles of 26-in. O D pipe; 24.6 miles of 24-in. O D pipe; 15.6 miles of 20½-in. O D pipe; 21.1 miles of 20-in. O D pipe; 13.4 miles of 16-in. O D pipe is to be completed.

O. R. Burden Construction Corporation, 6702 East 21st Street, Tulsa, Oklahoma, is managing to keep one spread at work on the Platte Pipe Line Company system, but pipe is none too plentiful. The field office has been moved from Moberly to Mexico, Missouri, where Barney Hall is superintendent, and Howard Smith office manager. This contractor will lay 280 miles of the Platte line, the section from the Missouri River near St. Joseph, Missouri, to Wood River, Illinois.

In Texas, 66 miles of 10-in. are being laid for Service Pipe Line Company between Bowie and the Brazos River. A crossing of the Brazos also is being made. The field office is at Olney. Floyd Lewis is superintendent and Ed Rensch office manager.

G. G. Griffis Construction Company, 2514½ East 15th Street, Tulsa, Oklahoma, is working on 210 miles of 26-in. loops for Northern Natural Gas Company. The pipe is being laid in Texas, Oklahoma, Kansas, and Nebraska. Included is a crossing of the Republican River in the vicinity of Clyde, Kansas. The field office is at Washington, Kansas. G. L. Mims is general superintendent, E. G. Grisham spreadman, and Mont Wood office manager.

Bechtel Corporation, 220 Bush Street, San Francisco, California, is proceeding with its work on 409 miles of 30-in. in Arkansas and Missouri for Texas Illinois Natural Gas Pipe Line Company. The project office is at 409 East Markham Street, Little Rock, Arkansas. E. W. Davis is division manager, R. F. Hamilton assistant project manager, E. G. Hayes division office manager, G. R. Curtis, project engineer, and E. C. Elting project office manager.

Spread offices are as follows:

Newport, Arkansas, general delivery —B. C. McLean, office manager.

Beebe, Arkansas, general delivery— J. L. Work, superintendent, C. G. Bingaman, office manager, and G. D. Page, job engineer.

Malvern, Arkansas, general delivery —V. L. Williams, superintendent, Harry Sager, office manager, and R. H. Hall, job engineer.

Arkansas River crossing, Box 349, North Little Rock, Arkansas—George Wahlgren, superintendent.

Puxico, Missouri, Box 10—C. E. Barker, assistant project manager; R. W. Jernigan, superintendent, E. C. Gavagan, office manager, and M. P. Boyle, job engineer.

Pocahontas, Arkansas, Box 122 — J. F. Barber, superintendent; R. L. McElroy, office manager, and W. L. Clark, job engineer.

Corning, Arkansas, general delivery —R. L. Bowman, superintendent; W. H. Molander, office manager, and H. J. Guerin, job engineer.

Trojan Construction Company, 1416½ North Robinson, Oklahoma City, Oklahoma, is now laying 50 miles of 30-in. pipe for Texas Eastern Transmission Corporation, from Ford to Moorhead, Kentucky. Work began in August. Headquarters are at Winchester. Charles T. "Swede" Tillotson is superintendent, Hubert Gragg spreadman, and Walter Wells office manager.

Western Pipe Line Constructors, Inc., Lockhart Building, Austin, Texas, has two spreads at work for Tennessee Gas Transmission Company. The spread working from Richmond, Kentucky, has W. B. Williams as its superintendent and P. O. Rutledge as office manager. At Dickson, Tennessee, Jack Hodges is in charge and A. G. Goyne is managing the office. Three river crossings also are being installed, the Duck, Buffalo, and Tennessee.

Anderson-Gibbs Company, 715 North Drennan Street, Houston, Texas, is installing a crossing of the Red River at Alexandria, Louisiana, for Texas Gas Transmission Corporation.

Vaughn and Taylor Construction Company, Inc., Box 1351, Wichita Falls, Texas, is constructing a 179-mile gathering system in the Ulysses, Kansas, area for Cities Service Gas Company, in pipe sizes ranging from 4 in. through 30 in. The field office is at Ulysses, with D. D. Vaughn superintendent and C. E. Sayles office manager.

MACHINERY FOR SALE OR LEASE

The John Fabick Tractor Company announces that it has purchased from Martin Wunderlich two super spreads of 30" pipeline equipment which is available for rental or sale—subject to prior sale or lease—F.O.B. cars Pennington, New Jersey, and Lansdale, Pennsylvania. If you are interested, call John Fabick Tractor Company, Trenton, New Jersey, or St. Louis, Missouri.

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1—"Caterpillar" D7—Non-Oscillating
2—"Caterpillar" D6's with Trackson Winches
2—"Caterpillar" No. 12 Motor Graders with scarifiers, 6—13:00x24 tires
1—"Caterpillar" No. 18 Ripper
2—Buckeye No. 51 Ditchers—"Caterpillar" D-13000 power
4—Allis Chalmers HD-19's with Berg Sidebooms and counterweights
3—Lorain ¾ yd. Diesel Backhoes—1 L41 and 2—TL25's
2—Koehring 304 Diesel—Dragline—Backhoe
3—¾ yd. Clamshell Buckets
4—Rud-O-Matic Taglines Model 636
2—Schramm 210 Air Compressors
10—Lincoln 300 Amp. Diesel Welders Model S-7068
27—Lincoln 200 Amp. Gas Welders Model S-6090
1—Alemite No. 2417 Portable Service Station
1—6"x20" Sand and Gravel Dredge Pump with 4—7'x7'x42' pontoons with Ford engines and 4 speed truck transmission—50'6" steel discharge pipe, 30'6" suction hose with boom and winch—priming pump
5—Dope Kettles on Athey tracks . . . 15-30 barrel capacity
2—Dope Kettles on Steel wheels . . . 10 barrel capacity
1—Dope Kettle on Half tracks . . . 23 barrel capacity
2—Perrault Cleaning and Priming machines
10—Crose 30# Beveling machines with out-of-round attachments
1—Crose Model U-4 Road Boring Machine with 70'18" auger, new cutter head, 6'32" auger.
2—Perrault 30"—5 roller pipe cradles
3—Perrault 30"—3 roller pipe cradles
1—Morris Hydraulic line up clamp with Poster-Ferguson push pull jack
6—30" line up clamp—Tipton and Morris
3—30" Superior Pipe Tongs
9—Poulan Model 44 Gas Chain Saws with G-34 Blade
4—14" Homelite Electric Chain Saws—Model E.C.S. 14
1—27" Homeite Gas Chain Saw Model 20 M.C.S.
2—Schramm No. 80 Paving Breaker
1—Gorman Rupp No. C54-14 Pump with Chrysler 6 cylinder engine
8—1½" to 6" Centrifugal Pumps—Marlow, Jaeger, Worthington and Gorman-Rupp
2—Kohler EU Gas Light Plants
1—M. J. Crose Power Buggy with 15GL Onan Electric Plant
2—Homelite Electric Plants Model 20A115L
2—Onan Electric Plants Model 15DL and 68AL
1—Sterling Light Plant Model UDC with Wisconsin AK Engine
1—U. S. Motors Electric Plant Model Q6N36
8—Gardner-Denver No. 55 Jackhammers
4—Dope Pot Engines (spares) Wisconsin and Continental
1—Dynamite House 2 ton capacity—New Jersey and Pennsylvania Specifications.
1—Cap box licensed in New Jersey and Pennsylvania
2—Licensed Day Dynamite Boxes—200# and 500#—New Jersey and Pennsylvania
2—International Half Track Trucks Model M9A1
4—1949 Chevrolet 1½ ton flat bed trucks with winches
4—1949 Chevrolet pick-ups with heaters
4—1949 Chevrolet 2 ton flat bed trucks with winches
1—1949 Chevrolet Suburban with heater
1—1949 Chevrolet bus
2—1948 Chevrolet 1½ ton flat bed trucks with winches
3—1950 Chevrolet 2 ton flat bed trucks with winches
5—1950 Chevrolet ½ ton pick-ups with heaters
1—1950 Chevrolet 1½ ton flat bed with winches
4—Dodge 4x4 Weapon carriers
4—GMC 6x6 Chassis with cabs
1—Jeep, 5 wheel drive
2—1950 Ford pick-ups with 6 cylinders
1—1950 Ford pick-up with 8 cylinders
"Caterpillar," Koehring and Buckeye Ditcher spare parts
5,000 feet of 0 and 00 new and used electric welding cable

Eastern Pipe Line Contractors, 1801 Mercantile Bank Building, Dallas, Texas, had laid approximately 30 miles (September 20) on the Texas Eastern Transmission Corporation job, which consists of 76 miles of 30-in. from the Tennessee River near Florence, Alabama, to a point near Columbia, Tennessee. The "going" has been a little tough because of rocks and hills. The field office has been moved from Florence to Lawrenceburg, Tennessee. Fred Byers is general superintendent, Cliff Simmons spreadman, and J. W. "Dub" Arthur office manager.

J. L. Cox and Son, Raytown, Missouri, (stringing contractors), are stringing 280 miles of 20-in. on the Platte Pipe Line Company system between West Alton, Illinois, and St. Joseph, Missouri, but have been held up due to lack of pipe. Another section on this system, 142 miles between Marysville, Kansas, and Holdrege, Nebraska, will start when pipe is available.

Near Plattsmouth, Nebraska, 19 miles of 16-in. for Northern Natural Gas Company, is nearing completion.

Latex Construction Company of Georgia, Box 56, Northside Branch, Atlanta, Georgia, is doing pump station and terminal work for Plantation Pipe Line Company on its expansion program. Station buildings are being enlarged to house additional units at Baton Rouge, Louisiana; Collins, Mississippi; Akron and Silver Run, Alabama; Bremen and Center, Georgia, and Spartanburg, South Carolina. Terminals are being enlarged at all main points between Baton Rouge and Charlotte, North Carolina.

Oman Construction Company, Inc., Box 146, Nashville, Tennessee, is working on 79½ miles of 30-in. pipe line in Kentucky for Texas Eastern Transmission Corporation. The field office is at Columbia. W. M. Smith is superintendent and Floyd Hudnell spreadman.

Parkhill Truck Company, P. O. Box 1856, Tulsa, Oklahoma, reports job progress as follows:

Texas Illinois Natural Gas Pipeline Company for Bechtel Corporation, 417 miles of 30-in. from Texarkana, Arkansas, to the Mississippi River near Cape Girardeau, Missouri. R. M. Hiser, foreman, Section 8 North; Frank Laubach, Section 8 South; Charles Sampson, Section No. 10; 80 per cent completed to September 15.

Texas Illinois Natural Gas Pipeline Company for Midwestern Constructors, 300 miles of 30-in. from Mississippi River to Joliet, Illinois. Harold Deatherage, foreman, Job 90 per cent completed.

Michigan-Consolidated Gas Corporation, 160 miles of 24-in. from Detroit to Big Rapids, Michigan. Cecil York and F. L. Bridges, foremen. Job 80 per cent completed. Anderson Brothers Corporation is the contractor.

Triangle Pipe Line Company for Anderson Brothers Corporation, 85 miles of 10-in. from El Dorado to Arkansas City, Arkansas. H. C. Peterson, foreman. Job 95 per cent completed.

Service Pipe Line Company, 29 miles of 6-in. near Haskell and Rochester, Texas. A. L. Hill, foreman.

For Anderson Brothers Corporation on Panhandle Eastern Pipe Line Company system, 60 miles of 26-in. in Michigan and Ohio. Ray Herron, foreman. Job 85 per cent completed.

For Somerville Construction Company on Phillips Petroleum Company, system, 67 miles of 8-in. from Farner City, Illinois, to East Chicago, Indiana. Curtis Williams, foreman.

For Brown-Lite Company on Phillips Petroleum Company job, 101 miles of 8-in. from East St. Louis to Farmer City, Illinois. O. C. York and Jimmie Stubblefield, foremen.

Ray L. Smith and Son, Inc., Hazlett Building, El Dorado, Kansas, are laying 58 miles of 20-in. for Texas Illinois Natural Gas Pipeline Company, from Joliet, Illinois, to the Volo meter station. The field office is at Aurora. The following personnel are in charge: R. M. Jones, superintendent; D. L. Marley, office manager; Charles Lewis, foreman of welders; Carlos Gayhart, pipe; Charles Pierce, dope; C. N. Leggitt, ditch; "Hub" Cisco, bending, and Rex Pickens, lowering-in.

Comstock Midwestern, Ltd., Leaside, Ontario, Canada, has been awarded a contract by Imperial Oil, Ltd., for the construction of 64 miles of pipe line between Sarnia and London. Work has begun and is expected to be completed by December. This is a part of the Sarnia-Toronto system. The London-Toronto section and the lateral to Hamilton will be laid next spring.

Mahoney Contracting Company, 2300 North Grand River, Lansing, Michigan, has begun work on the water crossings of Lake Maracaibo and the Gulf of Coro for Shell Caribbean Petroleum Company. The Lake Maracaibo crossing will consist of two 20-in. lines, each 5 miles long. The Gulf of Coro crossing will be a single 30-in. line 4 miles long. Angelo Tavernaro is in charge of the work.

For Texas Eastern Transmission Corporation, 100 miles of 30-in. pipe is being laid from the Kentucky River to the Ohio River in northeastern Kentucky. The field office is at South Shore, Kentucky. Barney Finnerty is the superintendent.

Another job for Texas Eastern is the 30-mile, 30-in. line being constructed from Connellsville, Pennsylvania, to the Oakford storage area near Greensburg. The field office is at the latter point, with Henry Mogg the superintendent.

Work is in progress on 70 miles of 8-in. through 24-in. for Dow Chemical Company in the Bay City, Midland, and Saginaw, Michigan, areas. The field office is at Midland. Ralph Bucher is superintendent.

H. B. Zachry Company, P. O. Box 2570, San Antonio 6, Texas, expects to complete about November 1 the 73 miles of 30-in. that is being laid between Lebanon and Columbia, Tennessee, for Texas Eastern Transmission Corporation. A. Vaughn is superintendent in charge.

Additions are being made to compressor stations at Bushton, Mullinville, and Clifton, Kansas, for Northern Natural Gas Company, and the work is expected to be completed about November 1. J. R. Johnson is general superintendent.

A bulk terminal station is being constructed for Humble Oil and Refining Company at Austin, Texas, E. J. Hermann being in charge.

Gulf Southern Contractors, 516½ Louisiana Avenue, Shreveport, Louisiana, has the contract to lay approximately 1000 miles of pipe line for United Gas Pipe Line Company in Louisiana, Texas, and Mississippi, including a marine line into the Gulf of Mexico. Gulf Southern is a contracting group consisting of River Construction Corporation, Fort Worth, Texas; Oklahoma Contracting Company, Dallas, Texas; J. Ray McDermott and Company, New Orleans, Louisiana, and Morrison-Knudsen Company, Inc., Boise, Idaho.

Reese Brothers Construction Company, Hugoton, Kansas, is installing an 181-mile gathering system for Northern Natural Gas Company in Texas County, Oklahoma, and Kearny, Finney, Haskell, Seward, and Morton counties, Kansas. Pipe sizes are 4, 6, and 8-in.

In the Hugoton gas area, a 50-mile gathering system is being laid for the Hugoton Production Company, the size of the pipe diameter being 4 in. through 22 in.

R. H. Fulton and Company, P. O. Box 1526, Lubbock, Texas, has one spread at work on the Platte Pipe Line Company system. Lack of pipe has made it impossible to put more men on the job. This contractor will lay approximately half of the system, its section being from Chatham station in Wyoming, to Brule, Nebraska. Pipe sizes are 16 and 20-in. The field office is at Douglas, Wyoming, with A. A. Carrigan superintendent and Dave Wagner office manager.

Meanwhile two spreads are at work on the Colorado Interstate Gas Company line from Kit Carson, Colorado, to the Canadian River north of Amarillo, Texas. The field office at Lamar, Colorado, has Jerry Nash as superintendent and Harry Jones as office manager. At Limon, Colorado, Ed Veach is in charge as superintendent and Van Albers is managing the office.

A total of 124 miles of 20, 24, and 26-in. loops is being laid for Northern Natural Gas Company between Sneed, Texas, and Olpe, Kansas. Field headquarters are at Dodge City, Kansas, M. L. Boyd is superintendent.

YOUNG

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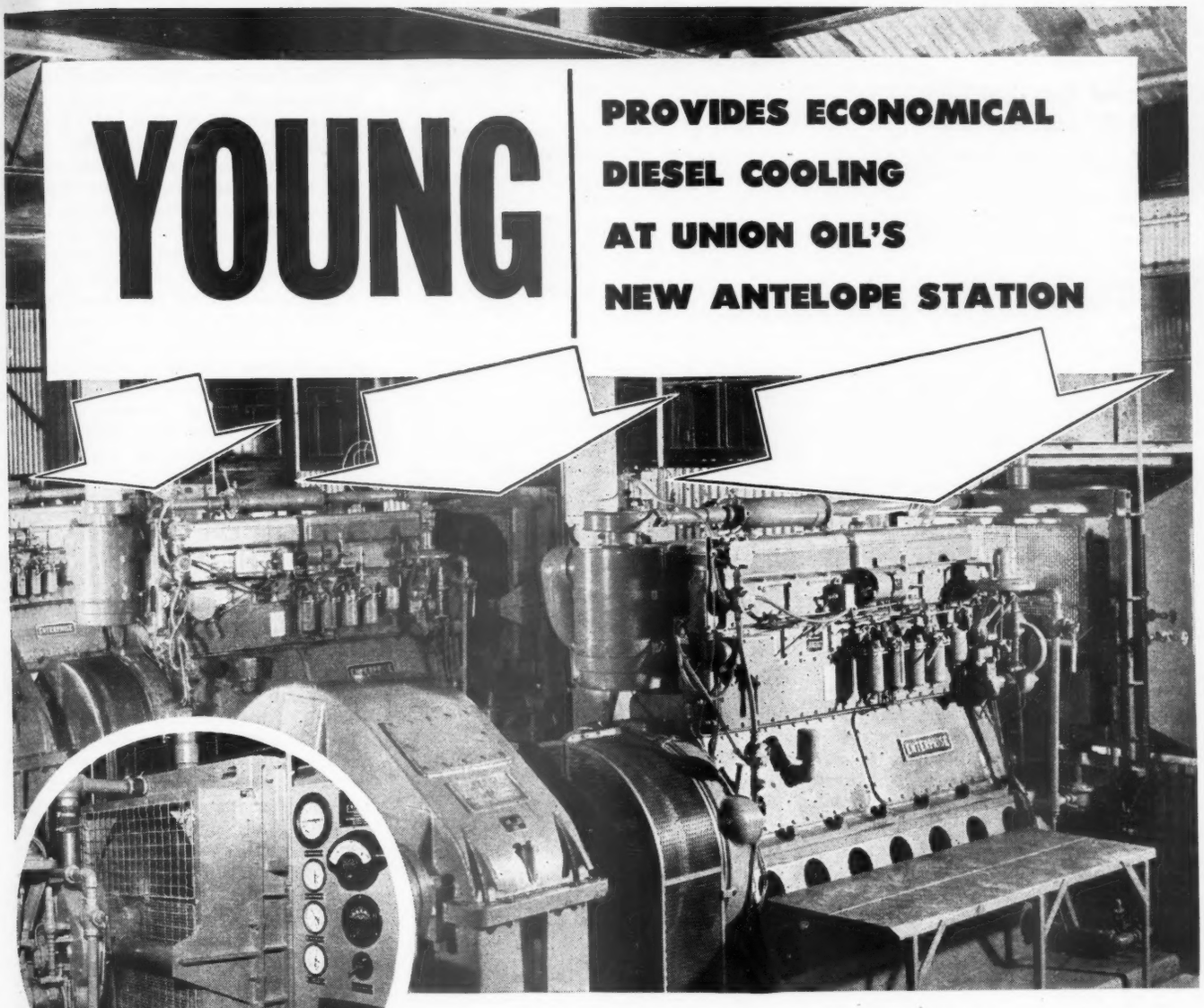

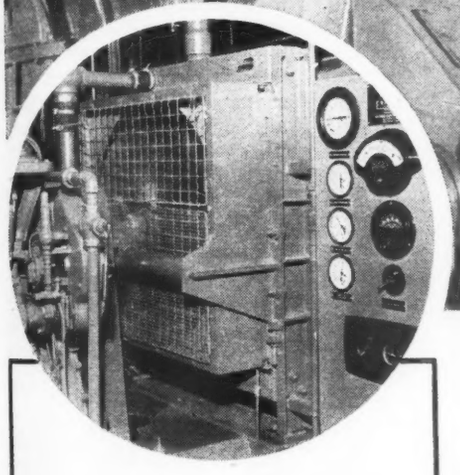

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Increased operating economy and self-sufficiency have been attained at the new Antelope Booster Station of the Union Oil Company. Young "Mono-Weld"* Radiators fit into the picture perfectly. They provide thrifty jacket water cooling for the three Enterprise Diesels installed. Also, the maintenance problem is minimized by the rugged welded steel construction of the Young units (see features at left) capable of withstanding the stresses of mobile equipment application. Your nearest Young Representative will gladly point out the advantages of "Mono-Weld"* Radiators for your applications.

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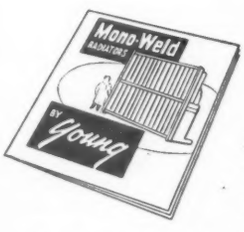

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NEWS

Oil and Gas Industry Steel Allocations Low

The Petroleum Administration for Defense has announced that the oil and gas industry received 59 per cent of the structural steel estimated by PAD to be required during the fourth quarter. This will mean a total of 60,000 tons beside a requested 102,123 tons.

In Washington recently a series of meetings were held by PAD officials and steel company men, who were urged to step up production of steel tubular goods. No official figure has been set yet as to the number of wells PAD will want drilled next year, but speculations are that it may go as high as 50,000.

Frank A. Watts, director of the PAD division on materials asked the steel companies to produce from expanded facilities more pipe of 5½-in. diam. Many drillers today are using 7-in. pipe where 5½-in. would be satisfactory, he pointed out, causing a loss of footage in favor of tonnage.

Fourteen oil and gas association representatives met in Washington recently for a conference with Deputy Petroleum Administrator Bruce Brown to revise standards for the allocation of oil country tubular goods. The meeting was reported a success, and almost sure to result in benefits to oil and gas producers.

In addition to steel shortage, limited nickel supplies have hit the manufacturers of drilling bits for the petroleum industry, the PAD revealed. Amount of nickel used is reduced from 3.5 to 1.75 per cent. At the same time, however, NPA has authorized an increase in the molybdenum content of the steel used in order to offset as far as possible the effects of the cutback in use of nickel. It is said the change in steel specification probably will mean that the life of the average rock bit will be reduced by from 3 to 5 per cent.

Rock bit manufacturers had been expecting such a reduction for some time, and experiments to improve the quality of steel were started early this year when it became apparent that several of the required alloys would be scarce. As a result some of the companies are ready to resume making the same quality bit.

Thus far the industry has not experienced shortages of drilling bits of any kind, in spite of the record rate of rotary drilling. Petroleum industry used about 720,000 rock bits in drilling nearly 200 million feet of hole annually in the United States and abroad. About 35,000 tons of steel and more than 1000 tons of nickel are used annually in rock bit manufacture.

NPA Bulletin Urges Scrap Steel Drive

Aimed to help increase the current dangerously low iron and steel scrap inventories in this country, the National Production Authority, U. S. Department of Commerce, is distributing a booklet, "Scrap for Steel Mills and Foundries for Defense," to more than 200,000 executives of business, industry and trade associations.

The booklet emphasizes that record-breaking steel production and large scale expansion of production capacity has reduced scrap inventories of mills and foundries to a new all-time low, with some plants having only a few days scrap supply on hand. If the nation is to achieve its 1951 goal of 110,000,000 tons of steel ingots and castings, 36,000,000 tons of purchased heavy industrial scrap must be found, the booklet says.

World Output Sets Record In First Half of 1951

The Petroleum Information Bureau in London has reported that world oil output rose to 11,600,000 bbl a day during the first half of 1951, hitting an all-time high. World production for the year will average about 1,100,000 bbl a day, including natural gasoline, the Bureau reported, if averages continue. Last year's average production was estimated at 10,500,000 bbl daily.

Estimates showed that leading producers for the first half of the year were: U. S. with 6,225,000; Venezuela, 1,623,000; Russia, 793,000; Saudi Arabia, 626,000; Iran, 615,000, and Kuwait, 430,000 bbl a day average. The item below shows Bureau of Mines report for February production.

February World Output Of Crude Oil Increased

World production of crude petroleum increased to 11,360,000 bbl daily in February, a gain of 106,000 bbl daily over the January average, the Bureau of Mines reports. The principal increases in daily average production were: Saudi Arabia, up 73,000 to 634,000 bbl; Iran, 56,000; United States, 23,000; Colombia, 6000; and Qatar, 5000 bbl. Venezuelan daily average production continued at record levels in February. The major decreases in daily production were: Kuwait, 63,000; and British Borneo, 5000 bbl.

Crude petroleum exports from Venezuela were 1,324,000 bbl daily, a decrease of 17,000 bbl daily from the January rate. Middle East crude exports (excluding shipments to Bahrein Island) decreased to 1,022,000 bbl daily from 1,086,000, principally because of a decline in Kuwait's offshore shipments from January.

B. B. Williams, board chairman of The Cooper-Bessemer Corporation, welcomes eight Peace Conference delegates of Japanese Diet (Parliament) during their visit to Mount Vernon, Ohio, to see a "typical small American city." Left to right are B. B. Williams, Hewitt A. Gehres, Cooper-Bessemer executive vice president; Kohei Kimura, chairman of the Commission; Akisada Okanishi, Takashi Ono, Eizo Kobayashi, Hideo Yamahana, Toyoji Takeshita, Masashi Aoki, and Shozaburo Sugita.

PAD Seeks to Fill Iranian Oil Loss

The U. S. Petroleum Administration for Defense has asked 19 American oil companies abroad to increase production in their overseas fields, and asked domestic American producers to expand their output. This is to help make up for the 610,000 bbl daily world deficit that will be left if Iran's oil is permanently lost to the western part of the world.

PAD estimated that American companies abroad can supply 230,000 bbl a day to the west, and if foreign-pumped oil usually shipped to the U. S. or Canada is diverted to others of the western allies, another 200,000 bbl a day will be accounted for. Oil normally received in the U. S. and Canada, which is going to other allies, is being made up at present from domestic storage.

Four States Deny PAD Gas Order

Maryland, West Virginia, and Wisconsin have joined with Virginia and have pulled out from under the Petroleum Administration for Defense order that restricts gas use in the states. A state public service commission can automatically exempt its territory from the PAD order by telling the President in writing that it has authority to restrict gas use in its state and is carrying out that authority in line with the defense effort.

The PAD order, issued recently, requires gas utilities to get the PAD's okay before taking on any new big volume gas customers.

PAD Urges Consumers To Fill LPG Tanks Early

Consumers and distributors of liquefied gas are being warned to fill their storage tanks during the waning summer and early fall in order to avoid spot shortages in winter. Secretary Chapman reported sufficient supplies of LPG to meet all demands, but stated that material shortages have impeded production of new pressure tank cars for transporting this type of fuel and of facilities for storing it.

Decision Awaited on Persian Gulf Rights

Superior Oil Company of California and Petroleum Development (Trucial Coast) Ltd., a subsidiary of Iraq Petroleum Company are awaiting a decision on which firm has the right to drill for oil off the shiekdom of Abu Dhabi in the Persian Gulf. The latter company is owned by British, French, American, Dutch, and Iranian interests. Trucial Coast has a concession dating back to 1939, which contends the oil rights include the sea bed under the Persian Gulf, but Sheik Shakbut Bin Sultan Bin Zai'd has declared the whole "continental shelf" area is under his control. He maintains he can legally give Superior an underwater concession if he wishes.

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Stanolind to Build Modern Research Center

With government approval of the project assured, Stanolind Oil and Gas Company is planning to go ahead immediately with the construction of its new research center here.

A. L. Solliday, executive vice president of Stanolind, said construction will get underway early this fall. Manhattan Construction Company has the construction contract. It is estimated that the job will take about 18 months to complete, unless delays are caused by shortages of building materials.

To be devoted almost entirely to research in petroleum exploration and production and to processes for making synthetic fuels and chemicals, the new research center will be one of the most modern and most complete in the oil industry.

Stanolind's research department, headed by George Roberts, Jr., manager, employs more than 425 people and has an annual payroll of more than $2 million. Virtually all of the present staff will be at the new location.

Activities of the research department are divided into four major areas: process research, of which Scott W. Walker is director; exploration research, headed by Daniel Silverman; production research, under Lloyd E. Elkins, and patent activities, directed by Paul F. Hawley.

Committee Members Named

The board of directors of the Alice Chamber of Commerce has announced committee appointments for the "South Texas Blowout", the celebration honoring the oil and gas industry of South Texas, scheduled for December 3 and 4. Included are: Chairman, H. Raymond Crow, president, Alice Chamber of Commerce; Robert M. Franks, chairman, Oil and Gas Committee; Fred Pool, executive secretary, and Nancy Heard, editor souvenir program.

Aluminum Production Up

Additional capacity recently placed in operation enabled the U. S. primary aluminum industry to increase its output about eight per cent in July, Donald M. White, secretary of The Aluminum Association, announced.

New Orleans Honors Firms During Oil Progress Week

Bruce K. Brown, Deputy Administrator, Petroleum Administration for Defense, on leave of absence from his presidency of Pan-Am, is in New Orleans for the dedication and celebration of Oil Progress Week.

Dr. Robert Wilson, Chairman of the Board of Standard of Indiana, will make a speech at the Members' Council of the New Orleans Chamber of Commerce on Thursday, October 18, and he and the entire board of the Standard Oil Company of Indiana will participate in the dedication ceremonies the following day of several new buildings. Pan-Am Southern Corporation will dedicate the new Lee-Circle Building, which houses its general offices. Humble Oil Company will dedicate a new office building, and in addition, The Texas Company has announced plans to commence constructing a new building in New Orleans.

NPC to Meet in Washington

Walter S. Hallanan, chairman of the National Petroleum Council has called a meeting of the council for October 31 in Washington. Hallanan stated he expected reports of special committees on oil and gas availability, a proposed expansion in output of petroleum products, underground storage for petroleum, and the council's findings of costs for producing commercially synthetic fuels.

Natural Gas Prices Set

The Office of Price Stabilization has re-affirmed its decision of August 22, 1951, approving a ceiling price on natural gas of 10 cents per 1000 cu ft at well-head in a proposed contract between the Stanolind Oil and Gas Corporation, Tulsa, Oklahoma, Continental Oil Company, Ponca City, Oklahoma, and the buyer, the Mississippi River Fuel Corporation, St. Louis, Missouri.

The two companies in question had sought OPS approval of a 12 cent per 1000 cu ft rate, included in an April 20, 1951 contract with the Mississppi River Fuel Corporation. The price was measured on the Texas pressure base of 14.65 psia at well-head for natural gas produced in the Woodlawn Field, Harrison County , Texas.

ASM Will Publish New Multi-Language Newspaper

The world's first multi-language newspaper in the field of metal science has been authorized for publication by the American Society for Metals, according to William H. Eisenman, executive secretary. The Society's board of trustees has allocated $50,000 to finance two-year preparations toward getting out an "International Journal of Metal Science." The organization's board of trustees will be publishing agency for the new paper until a world representative board of governors is selected, Eisenman disclosed. The new paper will appear in original languages of contributing writers and experts. Abstracts in English will be prepared by a staff yet to be selected, he said.

Air Purification Magazine

Publication of "Air Repair", a magazine devoted to the problems of air purification, was announced recently.

The new magazine is the official publication of the Air Pollution and Smoke Prevention Association of America, a 44 year old organization, which moved its headquarters from Chicago to Pittsburgh last winter. Its offices are now situated in Mellon Institute. The editor of "Air Repair" is Robert T. Griebling, a Fellow of Mellon Institute and Executive Secretary of the Association.

Colombia Takes Over De Mares Concession

The famous De Mares oil concession in Colombia has been transferred from the Tropical Oil Company to the Colombian government. Colombia repossessed an area of approximately 1,235,000 acres, which has been producing some 38,000 bbl of crude oil daily.

Tropical, subsidiary of International Petroleum Corporation of Canada, which in turn is an affiliate of Standard Jersey, relinquished the De Mares concession after 30 years. The concession will henceforth be exploited by Empresa Colombiana de Petroleos, a government company.

International Petroleum, however, is lending technical help and $10,000,000 for expansion of a refinery. The private company will also continue exploration in Colombia.

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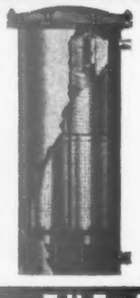

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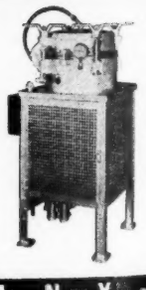

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OPS Sets Ceiling Price On East Texas Crude Oil

Office of Price Stabilization has established a specific ceiling price of $2.65 per barrel at the receiving tank for crude petroleum produced in the East Texas oil field, including the counties of Upshur, Gregg, Rusk, Smith, and Cherokee, as designated by the Railroad Commission of Texas.

The ceiling price was established by Supplementary Regulation No. 1, issued under Section 8 of CPR 32 and is effective at once.

The $2.65 price is now applicable to roughly 96 per cent of the production in this major oil field, according to information received by Director of Price Stabilization, Michael V. DiSalle.

Oil and Gas Law Institute To Meet in Dallas, Texas

The Southwestern Legal Foundation, Dallas, Texas, announces the Third Annual Institute on the Law of Oil and Gas and Taxation, to be presented January 17 through 19, 1952. The meeting will concentrate entirely on the subject of unit agreements and unit operations—a field that is rapidly gaining in importance among the oil and gas producing states. The Foundation has obtained as lecturers both lawyers and laymen eminently qualified in this field. The Institute will deal with the engineering aspects of unit operation; content of the royalty owner's and operator's unit agreement; anti-trust and other statutory restrictions on unit agreements; rights and remedies of the lessor and royalty owner under a unit operation; the problems of the tract that partially agrees to unit operation and the tract that refuses to consent to unit operation; unit operation of public lands, and many other subjects.

In addition to the foregoing, outstanding tax experts will again discuss the tax aspects of many oil and gas transactions as well as those arising out of the unit operation.

New NPA Officers

Earle M. Craig, of the Freedom-Valvoline Co., Freedom, Pennsylvania, was elected president of the National Petroleum Association at the 49th annual meeting in Atlantic City, New Jersey.

Craig who had been first vice president, succeeded W. S. Zehrung, president of Pennzoil Company, Oil City, Pa., as head of the association.

A. W. Scott, of Wolf's Head Oil Refining Company, Inc., Oil City, Pennsylvania, was advanced from second to first vice president. Fred G. Bannerot, Jr., of Elk Refining Company, Charleston, West Virginia, was named second vice president, succeeding Scott. G. B. Hunter, of Quaker State Oil Refining Corporation, Oil City, Pa., was re-elected treasurer, and Fayette B. Dow, of Washington, was re-elected general counsel.

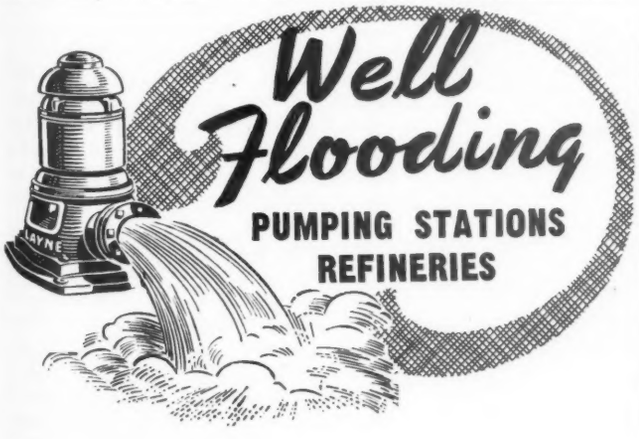
Opinion Divided on Synthetic Fuels Question

The controversy over Secretary of Interior Chapman's $455,000,000 synthetic fuel program is increasing. Top officials do not agree on the advisability of the government's sponsoring a plant at this time, and already two congressional committees have been brought into the investigation of the proposed plan.

Top scientists also disagree on a synthetic liquid fuels plant. Secretary Chapman and one group of scientists want to push on immediately and adopt the "coal hydrogenation" process for the initial venture. Dr. James Boyd, director of the Bureau of Mines, and other scientists feel that further study is required before any plants are built. Since the Bureau began its synthetic fuels research program in 1945 it has spent $60,000,000 on the work. An additional $27,000,000 has been authorized to continue research for 3 more years.

Russia Uses Satellite Oil

Moscow is seizing between 8,000,000 and 9,000,000 tons of oil annually from its European satellites, according to British Petroleum Press Service. This leaves a mere 5,000,000 or less for the limited and rationed domestic demands and their expanding industries in the satellite countries. Russia's own production totals 37,900,000 tons annually. Her efforts to step it up have not had too much success.



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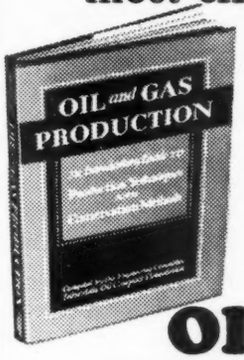

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Italy Plans to Expand Oil and Gas Industry

The Italian Government has plans for an enlarged oil and gas expansion program for the next few years, according to J. L. Cottrell, engineer for Rockwell Manufacturing Company, recently returned from Italy where he served for 30 days as observer and consulting engineer for Societa Nazionale Metadotti.

SNAM is a natural gas company owned by the Italian government, which had its first big discovery in the Caviaga field in 1941. Since then the government has developed 5 additional fields in the Po Valley, with wells ranging in depth from 4000 to 7000 ft, with large open flows at pressures from 200 to 2700 lb.

SNAM plans to develop a total of some 20 oil and gas producing fields in the Po Valley, north central Italy. It has built a new gasoline plant in the Cortemaggiore field, some 50 miles of the Caviaga field. The new plant will process some 100,000,000 cu ft of gas daily and make 800,000 gal of liquid hydrocarbons. The Italian government will expand its pipe line system to take care of 50 to 60 per cent of the total fuel requirements in the next few years, Cottrell reported, making Italy the only nation in Europe that will have enough natural gas to take care of the large portion of industrial fuel requirements.

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Embarrassed Fishermen Saved by a Halibut

Out off the Pacific Coast the albacore are laughing fit to burst over the futile efforts of a supposedly sharp group of piscatorialists who recently trolled all the way from Newport Beach to San Diego without a single long fin nibble.

The jaunt was all the more embarrassing because it was supposed to provide Art Langton, the popular bard, with material for a book on how to make albacore feel cheap, and in order that there would be no mistake he specially invited three sharpies who readily admitted that they were about the best tuna trappers in the petroleum industry. These were Bill Wilson and By Landis, a pair of yellow tigers from the Web Wilson outfit, and Dick McKey, The Petroleum Engineer's California advertising manager. They fished all day without catching anything but a bit of sunburn and were limping along toward the home port in the late afternoon, looking mighty disconsolate when a kindly halibut took pity on them and jumped aboard. It weighed 23½ lb and looked mighty nice on the McKey sideboard with a sprig of parsley in each ear. P. S. Art Langton has changed his mind about the albacore opus and will do a story on the graciousness of the *hyppoglossus hyppoglossus*, a heck of a name to give to such a friendly fish.

PEPA to Meet

The 23rd annual meeting of the Petroleum Electric Power Association will be held November 19 and 20 at the Shamrock hotel in Houston, Texas.

PEPA is an organization of electric power companies formed to render greater service, through cooperative effort, to the petroleum industry.

Freeport Makes Plans For New Sulfur Deposit

To develop the large new deposit of sulfur at the mouth of the Mississippi River, Freeport Sulphur Company will build a $10,000,000-$15,000,000 mining plant having a production goal of 500,000 long tons of sulfur a year, John Hay Whitney, chairman of the board of directors, and Langbourne M. Williams, Jr., president, announced.

The mine, the largest single sulfur development anywhere in the world in nearly 20 years, is expected to be ready for operation in 1953, the officials reported.

Garden Island Bay is situated in the marshes of the lower Mississippi River delta 100 miles southeast of New Orleans. The deposit is native sulfur, or brimstone, which is the cheapest and purest of the various forms of the element. The sulfur occurs in a typical salt dome formation. The dome was discovered by The Texas Company in exploring for oil, which is being produced from the flanks of the formation.

Oil Companies' Report Shows Demand, Income, Output Up

The petroleum industry in the United States showed increases in demand, crude production, income, and dividends for the first six months of 1951 as compared with a like period of 1950, according to the mid-year financial survey of 30 oil companies prepared by the petroleum department of the Chase National Bank. The 30 companies comprise about two-thirds of the petroleum industry in the United States. If present conditions hold throughout the remainder of the year, it is estimated that the gross operating income for the 30 oil companies may reach an all time high of $18 billion compared with the $15.3 billion for 1950. Net income of the group amounted to $999 million for the first six months of 1951, an increase of 41.5 per cent over the first half of 1950. Crude production of the entire United States petroleum industry during the first half of 1951 increased 20.2 per cent over the like period of 1950, while the demand for all oil products increased 12.8 per cent.

Chicago Vehicular Group Host to National Meet

The Chicago area section of the I. R. E. National Professional Group for Vehicular Communications will be host to the national conference of the association to be held at the Sheraton Hotel in Chicago, Illinois, October 25 and 26. R. V. Dondanville of Commonwealth Edison, a member of the I. R. E. Administrative Committee on Vehicular Communications, is Chairman of the Chicago area group. Kenneth V. Glentzer of Illinois Bell Telephone Company is Vice- Chairman, and William J. Weisz of Motorola is Secretary. Arrangements for the convention are being handled by Eugene S. Goebel of Motorola.

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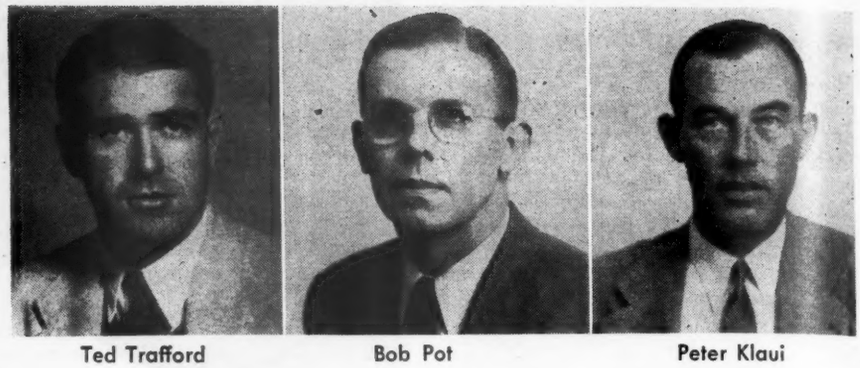

Ted Trafford Bob Pot Peter Klaui

Consulting Firm Set Up

A new consulting firm has been formed to be called Trafford and Associates for the purpose of supplying a fully integrated consulting service to the oil industry and to those associated either directly or indirectly with it. Senior members of the firm are Ted Trafford, manager; Bob Pot, and Peter Klaui.

Trafford has been brought up in the oil business having spent considerable time in Trinidad, where his father was an official of Trinidad Leaseholds Limited. After graduating from Cambridge University, he joined the Shell Oil group early in 1939. Later he served three years in executive posts with Shell's subsidiary, Anglo-Egyptian Oilfields Limited in Egypt, and in 1950 joined Home Oil Company.

Pot graduated in 1932 as a chemical Engineer and took a post graduate course in gas engineering. He then joined the Shell group in Venezuela. In 1946, he joined Imperial Oil in Calgary.

Klaui joined the Shell group in 1927 serving in Holland and later in the Dutch East Indies as a field geologist. In 1937 he joined Standard Oil of California in the East Indies, and in 1948 he was senior geologist for California Standard, moving to Bay Petroleum Corporation in 1949.

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Stach Receives Honor for Oil Operations in Japan

Leo. W. Stach, head of the Petroleum Branch, Natural Resources Section, General Headquarters, Supreme Commander for the Allied Powers, received a Certificate of Achievement from General Ridgway's Chief of Staff, Lieutenant General Doyle O. Hickey, at the termination of nearly six years' service with Lt. Col. Hubert G. Schenck, Chief of the Natural Resources Section.

In his capacity as petroleum geologist and administrative geologist during the Occupation of Japan, Stach was responsible for rehabilitating the Japanese petroleum producing industry to the extent that both production and proved reserves of crude oil in Japan are now nearly double what they were at the beginning of the Occupation, and average daily production is now exceeding the prewar peak.

Stach will remain in Japan for a few months to complete the publishing of Dr. K. Asano's Illustrated Catalogue of the Japanese Tertiary Smaller Foraminifera and the writing of a history of the petroleum industry of Japan.

New D & D Officers

Blanche Kelley, Union Oil Company, and Katherine Barnes, Schlumberger Well Surveying Corporation, both of Los Angeles, were recently elected officers in the Association of Desk and Derrick Clubs of North America. Miss Kelley was elected first vice president, Miss Barnes, regional director.

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Coastal Engineering Conference in November

Dean A. McGee, executive vice president of the Kerr-McGee Oil industries in Oklahoma City, has accepted the chairmanship of the Second Annual National Conference on Coastal Engineering at Houston, November 7 to 10, Conference Secretary Charles E. Balleisen of Southwest Research Institute has announced.

Balleisen also disclosed that Attorney General Price Daniel of Texas would speak on some phase of the tidelands question at the dinner November 7, and revealed the program would include talks by some of the best known authorities on coastal engineering, oceanography and meteorology in the nation.

S. J. Buchanan, Texas A. & M., will speak on "Foundation Problems on the Gulf Coast"; W. A. Price, Texas A. & M., "Ship Channel Orientation in Relation to Operation and Maintenance"; J. W. Johnson, University of California, "Generalized Wave Diffraction Diagrams;" Colonel E. E. Gesler, Beach Erosion Board, Washington, D. C., "Economies of Coastal Structures"; R. O. Reid, Texas A. & M., "Oceanographic Considerations in Marine Pipeline Construction"; "Design and Performance of Sea Walls in Mississippi Sound," F. Escoffier, Mobile District, Corps of Engineers; "Instrumentation for Oceanography", W. A. Mussen, Southwest Research Institute, and "Operational Forecasting," A. L. Glenn, A. L. Glenn and Associates, New Orleans.

Full information on the meeting is available from Southwest Research Institute which is sponsoring the conference together with a number of universities, colleges and professional and technical organizations in the area.

Egloff Reports on Middle East Oil for NPA

Dr. Gustav Egloff, Research Director for Universal Oil Products Company, in a recent report to the National Petroleum Association at the annual meeting in September, stated that the Middle East has the greatest reservoir of oil known in the world today. This resource must be protected as one of the most important factors in the security of Western civilization.

Dr. Egloff, a noted authority on all phases of oil, said the Middle East oil fields have an ultimate potential of 200 billion bbl of oil—worth more than three billion dollars. Proved reserves, he said, are over 40 billion bbl, about 46 per cent of the world's proved reserves, while the U. S. A. has about 30 billion bbl of proved reserves and 100 billion bbl potential.

"The vast richness of the Middle East countries, Iran, Saudi Arabia, Kuwait, Iraq, Qater and Bahrein is reflected in the average daily rate of production during 1950 which was 1,700,000 bbl from 315 wells averaging 5400 bbl each. In contrast, the U. S. A. averages 12 bbl a day from its 444,000 producing wells, or a total of about 5,400,000 a day," Dr. Egloff stated.

Summarizing the oil picture in Western Europe, Dr. Egloff noted that when the present refinery expansion program is completed over there, the import of refined products will decrease—but at the same time, the demand for crude oil itself will increase markedly. He continued:

"Although it is generally agreed that crude production in other Mid-Eastern countries can be increased sufficiently to offset the loss of Iranian crude, the shutdown of the Abadan refinery products is not so readily replaced.

In his country-by-country discussion of the Middle East, Dr. Egloff pointed out that the Anglo-Iranian Oil Company was a pioneer in the development of Iran—not only for the oil-producing facilities but also for the economic and social development of the country itself. "Without the Anglo-Iranian Oil Company, Iran would still have a largely primitive civilization. It is unfortunate that the Iranian leaders have thrown out those responsible for such progress."

Defense Theme Used to Push Controls: Brown

Russell B. Brown, general counsel of Independent Petroleum Association of America, at the annual meeting October 22-23 in Houston, warned of danger of governmental regulation. Brown stated that the drift toward increased controls under the guise of the defense program should have careful study by the industry.

He cited as foremost among current problems of the industry: Price controls, allocation of steel and materials, problems involved by the need of added taxes for support of the defense program, and tendency to inject additional governmental regulation and control of the oil industry in the name of the defense program.

"With respect to this latter problem there is a tendency by many governmental departments and agencies to examine all phases of the oil industry in the light of the vast powers now held by the federal government and to super-impose government planning on every activity of the industry," he said.

B. of M. Acquires Title to Synthetic Fuel Plant

The Missouri Ordnance Works, two miles south of Louisiana, Missouri, has been transferred to the Bureau of Mines to demonstrate production of synthetic liquid fuels from coal. The installation, known as the Synthetic Fuels Demonstration Plant, employs nearly 500 persons. Although the 391-acre expanse has been used by the Bureau of Mines since 1947, title had remained with the Army.

Regional Director H. P. Greenwald said the bureau will continue operating a 15,000-kw steam power plant built by the Army to serve the ordnance works.

Earth's Oil Supply May Be Endless, Says ASME President

The earth's oil reserves may be inexhaustible, J. Calvin Brown, president of The American Society of Mechanical Engineers, told the sixth annual conference of the petroleum division of the ASME at Tulsa. Quoting from a lecture of Dr. Robert A. Millikan, noted physicist, Brown said it is "orthodox astronomy" that the stars radiate away their masses through the mere act of giving off light and heat.

The sun, with its enormous interior temperatures of about 40 million degrees centigrade, transforms its mass into radiant energy, which is received by the earth where part of it is stored in coal and oil. Mother Earth has stowed away in coal alone enough solar atomic energy to keep us going for 4000 years at the world's present rate of use of heat and power. Brown declared:

"Therefore, there is some doubt whether or not we will exhaust all our oil supply, because if this energy sent to the earth from the sun is actually stored in the earth then oil will be continuously formed by a process of transformation."

To Make Mexican Oil Tour

House Interstate Commerce Committee Chairman Crosser (Ohio Republican) announced his committee would go to Mexico after Congress adjourns this fall to "resurvey the Mexican petroleum situation."

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PERSONALS

G. W. McCullough, former executive vice president and general manager of Phillips Chemical Company and Phillips Terminal Company, has been named chairman of the Operating Committee of Phillips Petroleum Company, replacing **J. E. Bogk** who resigned to enter private business.

T. L. Cubbage has been named vice president and general manager of both Phillips Chemical Company and Phillips Terminal Company and will direct operations of these two companies, the announcement continued. McCullough will continue as director and vice president of both companies.

McCullough, a graduate of Oklahoma A. and M. College, joined Phillips in 1925 as a draftsman and design engineer. He served as field construction inspector, chemist, and development engineer, chief process engineer, and was made chief engineer of the natural gasoline and gas department in 1943.

Cubbage, a graduate of the University of Oklahoma, joined Phillips in 1930 as resident engineer of the Capok plant at Oklahoma City. He was made superintendent of Phillips' Rice plant at Borger, Texas, in 1940 and became assistant superintendent of the Plains plant at Borger in 1943. He was made superintendent of the plant in 1944 and became vice president and assistant general manager in February.

E. Carl Mattern, OWIU (CIO) district director from Dallas, Texas, has been named consultant to Petroleum Administration for Defense. The appointment was made by Deputy PAD Administrator Bruce K. Brown. **O. A. Knight,** OWIU president, was recently appointed deputy administrator of the National Production Authority in charge of its office of labor requirements.

William E. Stiles

William E. Stiles has joined Buffalo Oil Company as vice president in charge of engineering, according to an announcement released by H. P. Taubman, president. Formerly manager of sales and assistant to the president of Core Laboratories, Inc., Stiles will direct the engineering development of the company's producing properties and its expanded program for acquiring additional secondary recovery properties.

W. K. Whiteford

Ole Berg, Jr.

M. E. Holmberg

William K. Whiteford has been named chairman of the board of The British American Oil Company, Limited, and **Ole Berg, Jr.,** has been named president of the company.

Whiteford was elected president of B-A in 1943, succeeding the late A. L. Ellsworth as chairman of the board. Berg joined the company as vice president and assistant to the president, and has recently been vice president in charge of marketing. He was appointed a director in 1948.

C. A. Breitung has resigned as gas supervisor of the gas department of the Railroad Commission of Texas. He will devote his entire time to private business.

Eugene D. Seraphine has joined Engineering Manpower Commission of Engineers Joint Council in the capacity of assistant executive secretary, where he will be responsible for public relations. Seraphine, former news bureau head for Colonial Airlines and public relations representative for American Overseas Airlines, will assist the Engineering Manpower Commission in their current national drive aimed at increasing engineering enrollments and utilizing present limited number most effectively.

Glen C. Riegel, chief metallurgist of the Caterpillar Tractor Company, Peoria, Illinois, has been named by the American Society for Metals to lead foreign and American experts in technical sessions at the World Metallurgical Congress in Detroit, Michigan.

In announcing Riegel's selection, William H. Eisenman, executive secretary of the society cited the nominee as "leader of recent steel production methods which save thousands of dollars a day and cut down on time and waste in metal fabrication."

"Riegel is the best there is in correlating heat treatment with ease of handling, yet sustaining the heavy duty quality necessary in big machinery," Eisenman added.

The Illinois metallurgist is noted for his development of new steel hardening methods. His process of heat applications to metals has cut expensive alloy content in steel and has revolutionized the manufacture of large gears for heavy machinery.

M. E. Holmberg, Southwestern metallurgist, has announced the opening of his consulting engineer offices in the Bermac Building, 4101 San Jacinto, Houston, Texas. For the past 15 years Holmberg has been associated with the Phillips Petroleum Company at Bartlesville, Oklahoma, where, for 10 years, he served as manager of Phillips test division.

"The science of metallurgy is comparatively new in the Southwest and in the oil industry," said Holmberg. He added, "I am, of course, hoping that the freedom of operation afforded by the owning and managing of my own business will enable me to help pioneer the metallurgical field in this area."

After his graduation in metallurgical engineering from Pennsylvania State College in 1931 Holmberg was employed by the Aluminum Company of America. In 1932 he went with Black, Sivalls and Bryson, Inc., as metallurgical and welding engineer. He transferred to the Phillips Petroleum Company in 1936 where he was similarly engaged in metallurgical testing and inspection.

H. T. O'Neill has been named treasurer and **Robert Donellan,** secretary of the British American Oil Company, Ltd. O'Neill will continue as vice president finance and Donellan as comptroller. Donellan joined B-A in 1930 and has been comptroller for the past six years. O'Neill joined the company in 1949 after serving many years with The Royal Bank of Canada.

Robert N. Sears, who recently returned from Washington, D. C., where he was on loan to the Petroleum Administration for Defense, has been appointed assistant to the executive staff of Phillips Petroleum Company. Sears was assistant to the president of Wasatch Oil Company in Salt Lake City, Utah, when it was purchased by Phillips in 1947. He also served as chairman of the Wasatch operating committee. Joining the economics department of Phillips in 1948 he worked on many special assignments, acting as Phillips representative in American Independent Oil Company matters.

After graduating from the University of Utah in 1936, he spent two years in the Harvard Graduate Business School, where he received a master's degree in business administration.

Forrest D. Best, a junior research engineer whose special research fields are machine and architectural design, has been named to the staff of Southwest Research Institute. Best's experience includes work on submarines, as well as studies in television for the American Television Institute of Technology.

Other appointments are:

Randolph Blumberg, research engineer who obtained his master of science degree in electrical engineering from Texas A. & M. and considers his special fields electrical engineering, mechanical solutions by electrical analogies using an a-c network calculator, and power system load flow, short-circuit studies.

Dr. Paul Louis Czibesz, who obtained his doctorate in engineering from the Polytechnical University at Budapest, Hungary, is a specialist in the fields of aircraft design, aerodynamics in boundary layer control, static testing, stress analysis, supersonics, applied mechanics and hydraulics, experimental hydrodynamics, electronics, instrumentation and flight testing.

Alfred E. Engel, Jr., research engineer, whose specialties include nuclear power, fluid mechanics, machine design.

Thomas P. Epperson, research engineer, who received his master of science degree from Virginia Polytechnic Institute and whose special fields include electronic instrumentation for static and dynamic measurements, and advanced dynamics, structures, elasticity, etc.

J. Wray Fogwell, mechanical engineer, who received his master of science degree from the University of Kansas, and whose special fields include mechanical design, product design and experimental stress analysis.

Dr. Robert B. Grant, supervisor of analytical mechanics, whose special fields include dynamics, vibrations, linear analysis, nonlinear mechanics, and system control analysis.

J. G. Joseph, whose special fields are industrial electronics and electro-mechanical systems.

Frederick E. Koebel, who received his master of science degree from Purdue University, and whose special fields are analysis and design of structures, stability and static testing.

M. M. Lemcoe, supervisor of aeroelasticity section, received his master of science degree from Washington University. His special research fields include flutter, dynamics, static testing, etc.

Willis L. Mynatt, foreman of experimental set-ups, lists his special fields as model development, laboratory test facilities, aircraft construction, and supersonic dynamic wind tunnel flutter tests.

Hester Franklin Sherfey, research engineer whose special fields of work are safety devices, conveyor equipment, steel and plant equipment.

James G. Steward, analytical mechanics specialist, received his master of science degree from Kansas State College and includes among his special research fields those of mathematics, statistics, numerical methods, and high speed digital computation.

Norman Hardy has been elected a vice president of the Arabian American Oil Company, it was announced by W. F. Moore, President. Hardy began his oil career in 1926 as a geologist with the Standard Oil Company of California. He has worked in Indonesia, Holland, and South America as well as in the United States. Prior to joining Aramco last February, Hardy was president of the Richmond Petroleum Corporation, a subsidiary of Standard Oil of California. His post will be in Dhahran, Saudi Arabia, field headquarters for Aramco.

DEATHS

Charles M. Cotton, 67, chairman of the Board of Directors of the Jergins Oil Company and a member of the Board of Directors of the Western Oil and Gas Association, died recently following surgery. He had been ill several weeks.

Cotton was active in the oil industry since 1922 when he and A. T. Jergins formed the A. T. Jergins Trust to participate in the early development of the Signal Hill oil field. The trust was incorporated as the Jergins Oil Company in 1928 and Cotton served as vice president and general manager until last year when the company was sold. Since that time he had served as chairman of the board of directors.

George M. Vandaveer, Jr., vice president in charge of production and engineering of Midstates Oil Corporation, died at Tulsa, Oklahoma, September 17, 1951.

Vandaveer was born June 19, 1902 at Bartlesville, Oklahoma. He received his B.S. degree in civil engineering from the University of Wyoming in 1925. He started his oil career that same year when he entered the employ of Midwest Refining Company at Midwest, Wyoming. Later he became engineer for the Montana Gas Corporation at Havre, Montana, and subsequently, was associated with Montana-Dakota Utilities Company. He joined E. H. Moore, Inc., at Tulsa, Oklahoma, in 1937, and following such employment he became Division Engineer for Phillips Petroleum Company. He joined Midstates in 1940 as Chief Engineer, was later made General Superintendent, and in 1949 was elected vice president of the company.

William S. Ackerman, retired employee of Tide Water Associated Oil Company, died recently.

Ackerman, one of the Tide Water Associated's longest service employees, retired last year after 46 years of active service with the company. He was 59 years of age at the time of his death.

Beginning as an office boy in the company's Los Angeles office in 1906, Ackerman held many important administrative positions while in the employ of the company. At the time of his retirement he occupied an executive position in the crude and products department, San Francisco general office.

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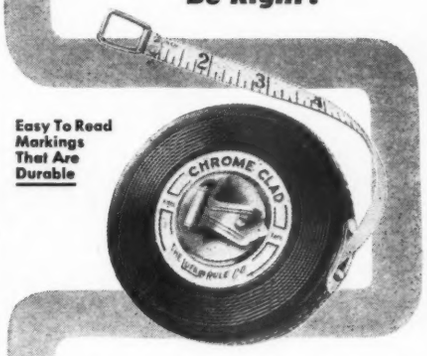

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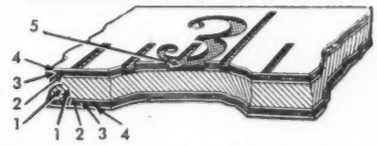

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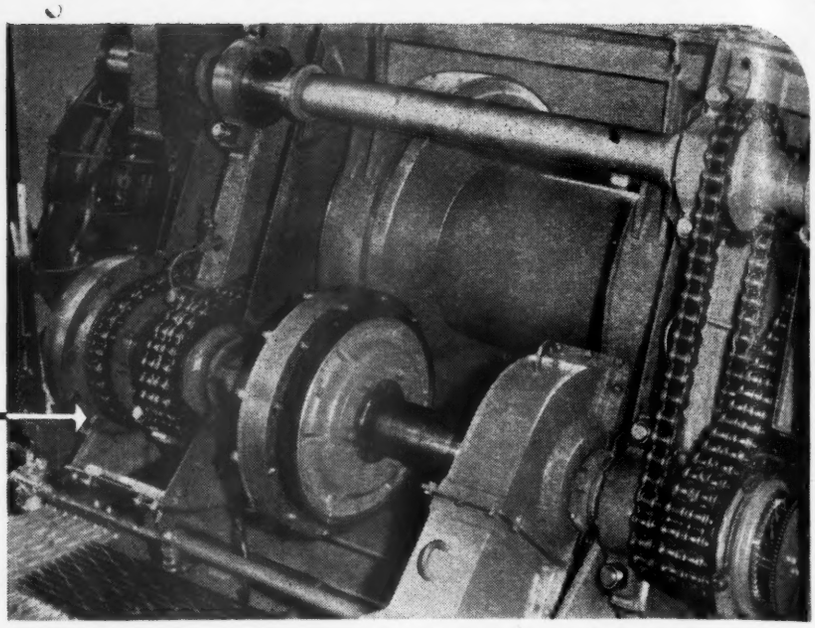

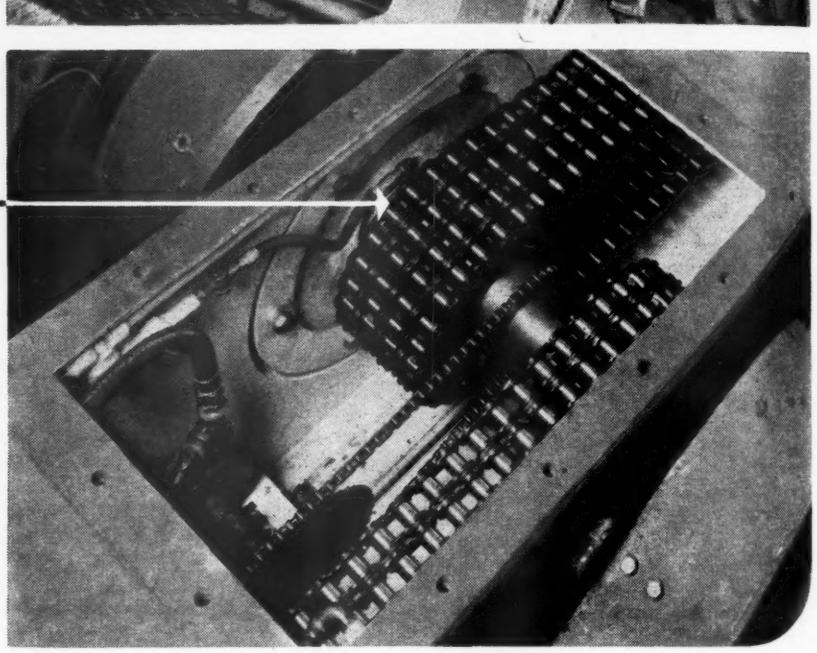

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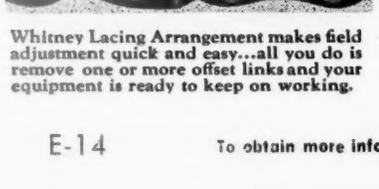

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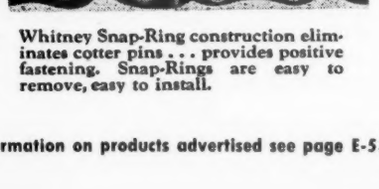

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LAUGH with BARNEY

Mischa Elman, the violinist was playing at a reception, and he says, "For an urchin of seven, as I was at that time, I flatter myself I rattled off Beethoven's 'Kreutzer Sonata' finely. The Sonata has in it several long and impressive rests. In one of these rests a motherly old lady leaned forward, patted my shoulder and said, 'Play something you know, dear'."

* * *

A man died and left $100 each to an Englishman, Irishman and a Scotsman, on condition that they each put $10 in his coffin.

The Englishman dropped in his $10 and the Irishman did likewise. Then along came the Scotsman, who put in the coffin a check for $30 and took out the $20.

* * *

Another old-timer we like is the one about the corpulent, self-complacent Irishman who sank into his most comfortable chair and remarked to his wife, "Well, Kate, me dear, life to me seems to have been one long run of prosperity. First I was plain Hooley; then I married you, and became Mr. Hooley; then I was made Counselor Hooley, and later Alderman Hooley. To cap the lot, as I wint into church yisterday, all the congregation with one accord, rose and sang, 'Hooley, Hooley, Hooley!' "

A rich asbestos manufacturer built a fine house just across the street from the minister of the local church. The manufacturer and his family then proceeded to enjoy themselves in what seemed to the minister to be a very worldly fashion and not once did he see them in church on Sunday.

But the minister was never known to speak ill of anyone. He only said to his wife:

"Dear me, they must have great faith in their asbestos."

* * *

Just returned from summer camp, Willie was enthusiastically describing the many diverting projects in which he had participated.

Mother smiled indulgently.

"I guess after all, dear, you were rather glad to get back home, weren't you?" she ventured.

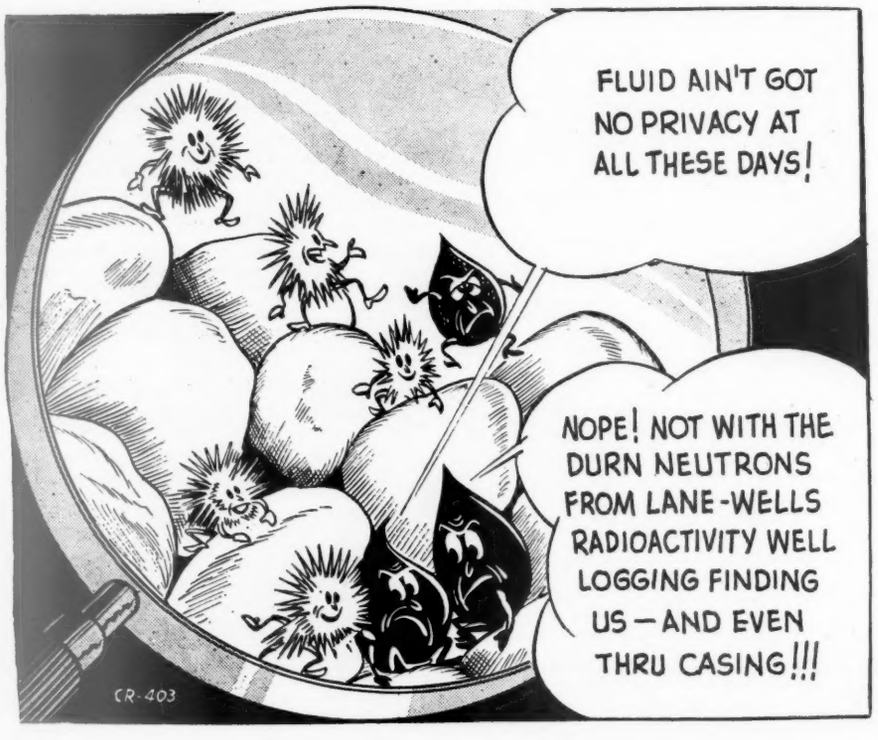
"Well, not 'specially," the youngster replied. "But some of the fellows were —that had dogs."

* * *

The Negro was applying for relief, and the girl at the desk was filling out the questionnaire.

"Do you owe any back house rent?" she inquired.

"Ma'am," he replied with dignity, "we've got modern plumbing!"


FLUID AIN'T GOT NO PRIVACY AT ALL THESE DAYS!
NOPE! NOT WITH THE DURN NEUTRONS FROM LANE-WELLS RADIOACTIVITY WELL LOGGING FINDING US—AND EVEN THRU CASING!!!
CR-403

The bride was displaying her wedding gifts. When she came to one from the groom's Army buddy, she remarked: "I just adore the personalized gifts. We received towels and washcloths with HIS and HERS on them, but this is even more personal."

And she blushed as she fingered an olive drab blanket with the letters US stamped in the middle.

* * *

"Buck up, old man! Why don't you drown your sorrow?"

"Can't. She's stronger than I am.'

* * *

Before I heard the doctors tell
The dangers of a kiss
I had considered kissing you
The nearest thing to bliss.
But now I know biology
And sit and sigh and moan,
Six million mad bacteria—
And I thought we were alone.

* * *

Paying no attention to the red traffic light, the whizzing cars, or the policeman's outraged whistle, the little old lady marched across the street. Brakes squealed, horns blasted, and the cop strode angrily up to her. "Say, Lady," he growled, "didn't you see my hand raised? Don't you know what that means?"

"Well, I should hope I do," snapped the lady. "I've been teaching school for 25 years!"

* * *

A certain lady who had just completed a course in first aid was horrified while walking along to see a man lying flat on his face in the middle of the street. A few spectators were standing around, and the lady was shocked to see no one doing anything for the stricken man.

"Keep cool, everybody," she screamed, and rushing to the man, knelt over him and started applying artificial respiration.

Suddenly the man looked up and said, "Lady, it's a tough job getting this wire down this manhole, and you sure aren't helping much."

* * *

Boss to secretary: Make 20 copies of this, Miss Ross, so we'll run across one when we need it.

* * *

"Your son is making good progress with his violin," remarked a musician friend of the family. "He is beginning to play quite well."

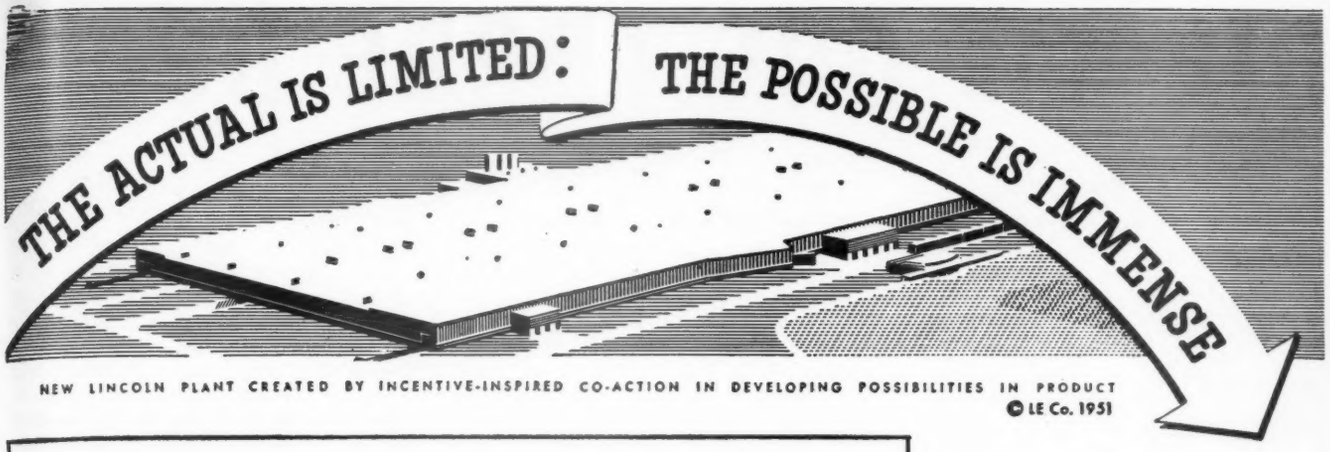
"Do you really think so?" beamed the father. "We were afraid that we merely had become used to it."

* * *

Judge (to prisoner aged sixty): The sentence is thirty years penal servitude.

Prisoner (in tears): Your honor, I shall not live long enough to serve the sentence.

Judge (in kindly tone): Don't worry, do what you can.



NEW LINCOLN PLANT CREATED BY INCENTIVE-INSPIRED CO-ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT

© LE Co. 1951

BOOSTS WELDING SPEED 4 TIMES

..for faster, lower cost fabrication

LINCOLN'S automatic hidden-arc welding with granular flux, long used for double jointing, now fabricates all types of processing equipment for less cost. Utilizing the high current density and deep penetration obtained by concentrating up to 600 amps on a 5/64" wire, welding speeds are being increased 2 to 4 times with joint preparation almost entirely eliminated on plates up to ¾".

"Manual Lincolnweld" combines the benefits of hidden-arc welding with the flexible operation of manual welding with coated electrodes. Electrode feed is continuous and automatic and the operator can guide the gun around obstacles or along irregular curves. Granular flux is directed to the joint by the welding gun, enabling stronger, higher quality welds to be produced often in one pass on all flat and near flat work.

Savings up to 50% are reported by fabricators of oil field equipment, along with higher quality of production and improved operating conditions in the shop.

Fig. 3—Fabricates tank *with conventional work handling equipment used for band welding. Welding speed is 20 inches per minute.*

Fig. 4—Ideal in confined areas *to provide easy, low cost method for applying speed and penetration of hidden-arc welding on jobs formerly restricted to hand welding.*

SPEEDS DOUBLE JOINTING

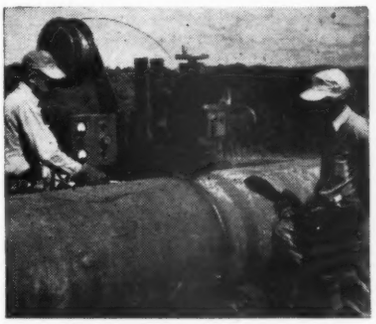


Fig. 1—Double jointing 30" pipe *at welding speeds of 54" to 60" per minute with "Automatic Lincolnweld." Crew of 18 to 24 men completes 8 to 10 joints per hour.*

LAYS PIPE FASTER

Fig. 2—Field welding 30" line *with "Fleetweld" 5 and Lincoln "Shield-Arc" engine driven welders. Joints pressure tested to 800 psi are found free of porosity.*

LINCOLN COMBINES HIDDEN ARC WITH MANUAL WELDING TO CUT COSTS

Send for Bulletin 1303 "Manual Lincolnweld". Write to Dept. 186,

THE LINCOLN ELECTRIC COMPANY

CLEVELAND 1, OHIO

OIL AND GAS TRADE NEWS

Byron Jackson Purchases Dempsey Pump Company

The Byron Jackson Company has announced the purchase of the Dempsey Pump Company's business in Tulsa, Oklahoma. The Dempsey pump, first introduced to the public in 1948. incorporates a method of oil well pumping without the use of sucker rods. Among the features stressed on the Dempsey pump are the usual oil well pump combined with a subsurface hydraulically actuated driving mechanism. Operations at the Dempsey plant will be headed by V. C. (Bud) Horner, transferred from Houston.

V. C. Horner

Engineering Office Set Up

Arthur G. McKee and Company, Cleveland, Ohio, engineers and contractors in the petroleum refining and iron and steel industries, announce the opening of an engineering office at Tulsa, Oklahoma, to serve customers in the Southwest. Other engineering offices are those at the company's headquarters in Cleveland and at Union, New Jersey. The Tulsa office will be headed by R. P. Mase, Southwest sales representative.

Babcock and Wilcox Plan Subcontracts, New Plant

Expanded use of subcontracted facilities, plus plans for a new plant, have been made in recent weeks by The Babcock and Wilcox Company, C. H. Gay, vice president, has announced. The facilities, situated in the East and South, will add to the company's regular force of 14,000 a possible 1900 employees. The reason for the expansion, Gay explained, was to have available necessary fabricating operations to speed production of badly needed boiler parts when anticipated increases in steel and other materials become available during the fourth quarter of the year.

Alcoa Expands Facilities

Aluminum Company of America is expanding its research facilities with the erection of a new building at the company's Aluminum Research Laboratories at New Kensington, Pennsylvania, according to Dr. Francis C. Frary, ALCOA'S director of research. The new unit — measuring 80 by 170 ft — is needed to relieve congestion and to extend ALCOA's research facilities to meet increasing demands of the national defense program. It will increase total floor space at the laboratories by about one-third. Construction is already under way, and the building will be ready for occupancy early next year.

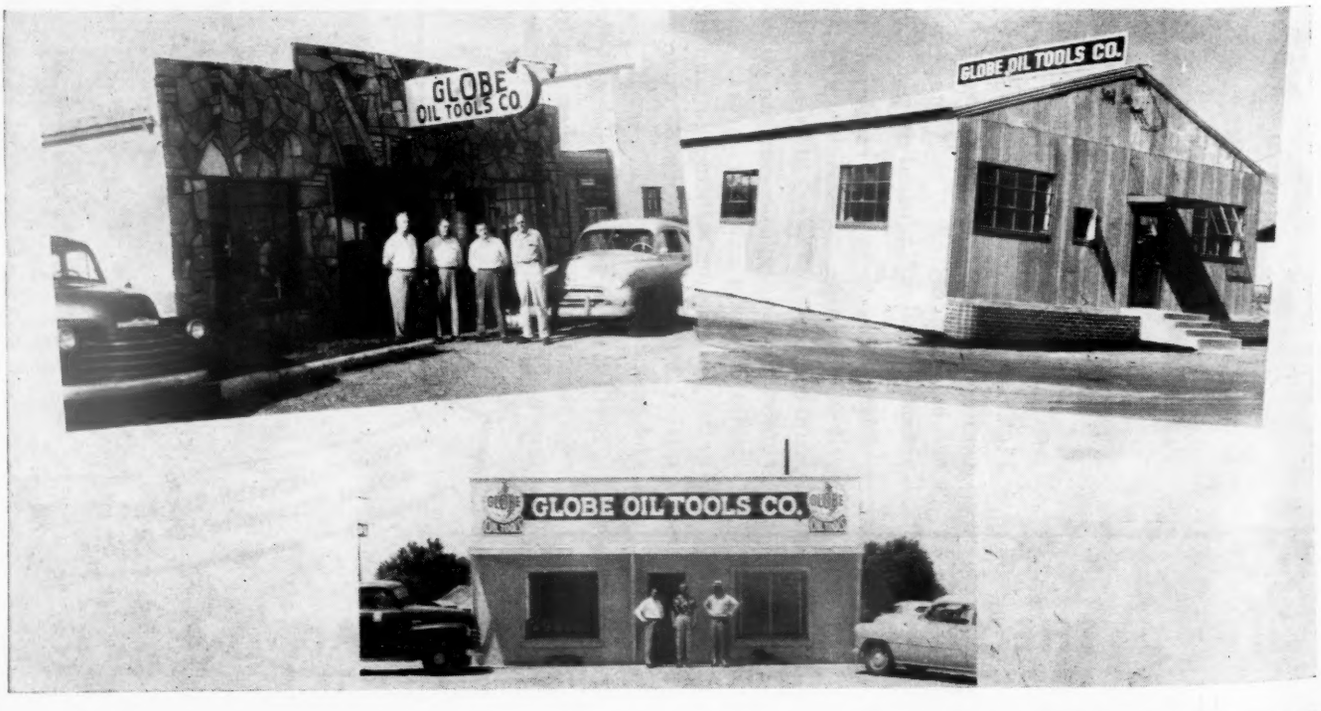
Johns-Manville To Make Diatomite Filter Aids

Shortages of many diatomite filter aids and fillers in recent months should be relieved by the end of this year. At that time Johns-Manville, a major producer of these materials, expects to have in operation new equipment, which will increase the company's production in these lines by about 40 per cent, according to Arthur E. Elsenbast, vice president of Johns-Manville and general manager of the Celite division. The heart of the new system is a large rotary kiln 10 ft in diameter and 110 ft long. One unusual feature of the kiln is a stainless steel lining. Diatomite will be calcined in this kiln at temperatures of 1800-2000 F. This treatment removes all organic matter, free and combined water from the raw diatomite and changes the crystalline form as well as the size of the particles.

Pipe Mill Installed

A new electric weld pipe mill will be installed in the Berkeley, California, plant of Consolidated Western Steel Corporation, it was announced by Alden G. Roach, president of this U. S. Steel subsidiary. The new mill will produce electric welded thin API line pipe in sizes ranging from 4½ in. to 8⅝ in. diam for use in oil and gas transmission and distribution lines.

Globe Oil Tool Company has opened three new field stores in Ventura, California; Odessa, Texas, and Duncan, Oklahoma. Tom Ashe and Jack Goodwin, Globe vice president and chief engineer, respectively, were on hand when their stores at Duncan (left) and Odessa (center) were opened. Clark and Warner Greer work out of the Duncan store, and H. D. "Spec" Donham makes his headquarters at Odessa. Harold Mears and "Doc" Cook service the Ventura area from their new store (right).



De Laval Steam Turbine Company's new San Francisco headquarters. The new building is at 160 Folsom Street and will be headquarters for sales and service. The new office, which will provide increased warehouse facilities, will be headed by C. F. Reeves, left, who has been in charge of De Laval's West Coast sales. Service orders can now be handled more promptly.

Hanley

Bendean

Gilbride

Nelson

Clark Office Established for Sales and Service

Clark Brothers Company, Inc., Olean, New York announce the opening of new sales and service offices at Pittsburgh, Pennsylvania. The territory covered by the new office, which is situated at 2920 Koppers Building, was formerly served by William H. Bendean directly from the factory at Olean, New York. District manager in charge of the Pittsburgh office will be Sidney S. Hanley who has been working with Bendean out of the Olean office for the past five years. Prior to his field experience. Handley worked in the technical sales department on specialized projects.

Another member of the Pittsburgh office will be James D. Gilbride. A Cornell graduate, Gilbride will work with Hanley in serving the many oil and gas companies throughout the territory. To meet the demand for Clark balanced-opposed motor driven industrial compressors, Robert T. Nelson, a RIT graduate, will work with Hanley in the new office.

Whitney Chain Moves Into New Headquarters

The Whitney Chain Company of Hartford, Connecticut announces the removal of their district sales office to new and larger quarters at 70 Dorman Avenue, San Francisco, California. The office is under the direction of George F. Haag, district manager. The new headquarters will function as the engineering sales outlet for the complete line of Whitney power transmission and conveying chain, couplings and sprockets in the San Francisco and Northern California regions.

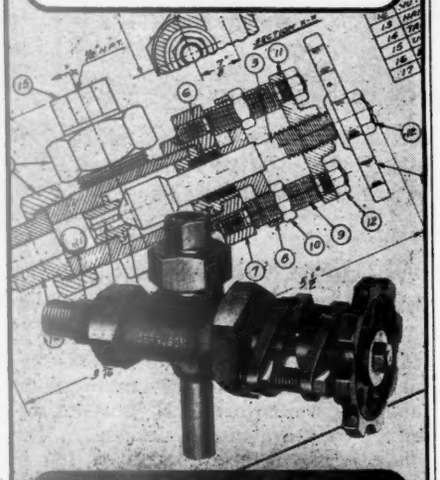
Grant Oil Office Set Up

Grant Oil Tool Company, announces the opening of a sales and service branch at Compton, California, under the management of Curt Linkey, widely experienced oil operator. The new branch is equipped with adequate warehousing space and facilities to take care of the company's customers in any and all parts of the Los Angeles basin, which will expedite service.

The Marley Company plant in 8 ft of water. The above picture was taken during the Kansas City flood. The water did not reach the company's executive office and engineering departments. Drawings, plans, and records were unaffected.

Three weeks later the Marley plant was back producing cooling towers and mechanical equipment at its Kansas City plant. Three days after evacuating the plant, several departments were operating in temporary quarters at a local high school.

BEST FOR HIGH TEMPERATURE AND CORROSIVE SERVICES



JERGUSON OS&Y VALVES
Eliminate Stem Freezing

YOU'LL be sure of dependable performance under high temperature or corrosive service conditions when you use rugged Jerguson Outside Screw and Yoke Valves.

These Jerguson OS&Y Valves are made to withstand severe service, and are the ideal answer for high temperature and corrosive services where inside threads cannot be tolerated. Jerguson's efficient outside thread design allows the valve stem to work freely at all times, and forestalls possible freezing.

Jerguson OS&Y Valves are available in any alloy in order to better handle corrosive media; can be repacked under pressure; have renewable and regrindable seats; and are available with Teflon or other special packing. Outlets may be on center line of valve, or offset 7/8". *The Jerguson OS&Y feature may be added to existing installations of Jerguson #50 or #60 Valves.*

Write for full information on Jerguson OS&Y Valves

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
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Representatives in Major Cities
Phone Listed Under JERGUSON
Jerguson Tress Gage & Valve Co. Ltd., London, Eng.

National Supply Store Opened in Illinois

The National Supply Company has opened a store in Robinson, Crawford County, Illinois. This general oil field supply outlet has been opened to enable the company to offer better service to its customers in that area. National Supply has nine other stores in Illinois. The Robinson store is under the management of Wayne A. Brown, transferred from the company's Crossville, Illinois, store. Field representatives for the area, Pearl A. (Steamer) White, transferred from Lawrenceville, Illinois, territory and has been with National since 1941.

Barnes Buys West Coast Pump Manufacturing Plant

Purchase of a West Coast pump manufacturing plant by Barnes Manufacturing Company, Mansfield, Ohio, has just been announced by Millard H. Pryor, president of Barnes. The transaction involves the purchase of all of the assets of the Shasta Pump Company in Oakland, California. From now on it will operate as a wholly owned subsidiary manufacturing the complete line of Barnes pumps for distribution on the West Coast. The new organization will be known as Barnes-Shasta Pump Company and will continue to manufacture in Oakland the former Shasta line augmented by the complete Barnes line now manufactured in the Mansfield plant.

Cleco Appoints Two Agents in California

The Cleco division of the Reed Roller Bit Company, Houston, Texas, has announced the appointment of Elect Air Tool Company, 310 West Verdugo Avenue, Burbank, California, and W. E. Mushet Company, 725 Bryant Street, San Francisco 7, California, as distributors for Cleco products in their areas. Cleco manufactures the Cleco and Dallett lines of air tools and accessories—including tools for construction, manufacturing, metal fabrication, foundries, industrial maintenance, and stone carving.

National Supply Installs New Handling Equipment

The National Supply Company has installed modern material handling equipment at its Odessa, Texas, store. In addition to its own business, this store serves as a distribution center for all adjacent National Supply store points. The equipment used consists of a 4000-lb capacity industrial truck of the fork type; a supply of 42 by 48 in. wooden pallets; an overhead traveling crane for handling of heavy items, and a 10-ton capacity elevator that services not only the basement and the warehouse area, but also the craneway. The powered fork truck also works in all three of these areas. All items that permit are palletized, then tiered directly on the floor of the 40,000-sq ft warehouse, or placed in steel racks that rise vertically some 11 ft. In addition, palletized items are stored in sections of a 90,000-sq ft yard area adjoining.

Natchez Store Opened By Mid-Continent Supply

Ken W. Davis, president of Mid-Continent Supply Company has announced the opening of the company's newest field supply store at Natchez, Mississippi. This store is the newest addition to the Mid-Continent chain of branch stores. Situated at 102 Main Street, the new store is under the direction of F. A. Burge. It comes under the supervision of Mid-Continent's Mississippi, Louisiana, Arkansas division, which is headed by C. M. Fleeman, division manager, with headquarters in Shreveport, Louisiana. G. H. Canterbury and A. M. Thompson are field salesmen at the store and R. H. Wallace, Isaac Foster, and J. B. Timmons are storemen.

Gustin-Bacon Recovers From Kansas City Flood

Gustin - Bacon Manufacturing Company, manufacturers of Rolagrip and Gruvagrip pipe couplings and distributors of Ansul and Rockwood fire fighting equipment, announces their return to almost normal production following the devastating flood in the Kansas City area recently. The first floors of all seven of the company's plants in the greater Kansas City area were inundated by the rampaging waters of two great rivers that join at Kansas City. Fortunately, finished goods inventories were stored on higher floors.

Through quickly organized around-the-clock clean-up work, all plants are now in limited or full production. Shipments are being made daily to supply stores.

Ad Men Form New Agency

Herb Hill and Jim Christopher have formed their own agency under the name of Hill and Christopher, Advertising. Offices are opposite MacArthur Park at 2024 West Sixth Street, Los Angeles. Hill brings the Halliburton Oil Well Cementing Company account to the agency and will serve as senior account executive and director of advertising design. Christopher, who operated his own agency for the past two years, has 15 active accounts covering almost every classification and will serve as senior account executive, copy chief, and agency manager.

Pacific Coast Offices Moved to New Site

The Babcock and Wilcox Tube Company's Pacific Coast office, formerly at 714 Olympic Boulevard in Los Angeles, California, will now be in larger quarters in the Lawson-Chipman Building at 1111 Wilshire Boulevard, according to H. F. Lefferty, Pacific Coast manager for the company.

Lane-Wells Opens Denver Sales Office

Lane-Wells Company has opened a sales office in the Patterson building in Denver, Colorado, under the direction of Ed Saye III, district sales engineer. Saye, a graduate petroleum engineer from the University of Oklahoma, has been connected with the petroleum industry for most of the last 12 years. He has been active in the Mid-Continent area since 1946 when he joined Lane-Wells. Saye has spent considerable time in both the operating and engineering departments as well as the sales activities of the company.

Ed Saye

Gear Making Plant To Be Constructed

Beginning of new construction that will increase gear-manufacturing capacity by 30 per cent at the Lynwood, California plant of Western Gear Works has been disclosed by Thomas J. Bannan, president. This is reported to be the first in a series of expansion moves planned for this Southern California plant of the company. Construction of a new plant by the same company is currently underway at Belmont.

American Meter Opens New Dallas, Texas, Plant

American Meter Company, Philadelphia, Pennsylvania, has opened a new orifice meter plant with display rooms at Dallas, Texas. Equipment related to orifice meters, such as orifice plates, flanges, needle valves, fittings, and gage line connections will also be produced. According to William G. Hamilton, Jr., American Meter president, the new facilities will provide instrument people in the Southwest with many on-the-spot conveniences including engineering consultation on instrument problems. Donald C. Holtz of Erie, Pennsylvania, will manage the new plant.

Welex To Conduct Radioactivity Survey

Welex Jet Services, Inc., Fort Worth, Texas, has entered into a license agreement with Well Surveys, Inc., Tulsa, Oklahoma, to conduct radioactivity well surveying operations under WSI patents. Welex is the second service company to be licensed by Well Surveys, Inc., to operate in the United States. The Welex logging trucks and equipment are now in process of being assembled. At present Welex is rendering jet perforating services for both casing perforating and open hole shooting. Date when Radioactivity Well Logging services will be available from Welex in the field has not been announced.

DURAMETALLIC

Packings

SAVE DOLLARS

The bearing-like sealing provided by Durametallic Flexible Metallic Packing means minimum wear on rods, shafts and sleeves! Genuine maintenance savings for you in repair, replacement and shutdown costs. . . . .

"Always Specify DURAMETALLIC"

WRITE FOR DURAMETALLIC PACKING BULLETIN NO. 429 PE

The PERFECT SEAL

DURAMETALLIC CORPORATION

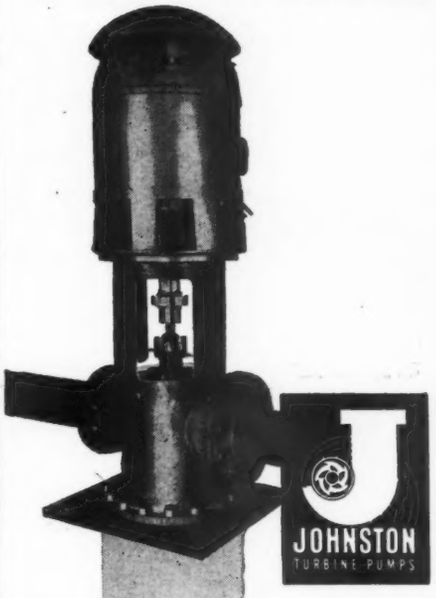
KALAMAZOO MICHIGAN

MANUFACTURERS OF METALLIC and SEMI-METALLIC PACKINGS

ROTARY MECHANICAL SEALS and PACKING TOOLS

No Other Pump Like It!

HEADS TO 1000 FEET!
TEMPERATURES TO 400° F.!
CAPACITIES TO 3000 G.P.M.!



Tough specifications to meet...sure, but the new Johnston Vertical Turbine Pump designed to handle volatile liquids and liquids near the boiling point does it without even breathing hard . . . Proven performance in the refineries of several large oil companies is a matter of record.

This unit, which has the pump bowls enclosed in a sealed steel barrel, takes suction sufficiently above the pump bowls to give the required net positive suction head. The discharge can be at the same level as the suction or higher if necessary. Where there is a limited net positive suction head, such a unit offers many advantages:

1. The supply vessel can be located wherever convenient and the pump bowls then set low enough for proper submergence.
2. Driver and piping connections are at the surface, eliminating dry sumps which are costly to build and expensive to maintain.
3. Nothing to lubricate but driver bearings.
4. Vertical design needs only ⅓ as much valuable floor space.
5. Due to diffuser type construction, this unit has higher efficiencies than conventional centrifugal pumps at high heads.

Technical papers on the Johnston Volatile Liquid Pump are available. Send for as many copies as you need for interested personnel.

JOHNSTON PUMP COMPANY

3272 E. FOOTHILL BLVD.

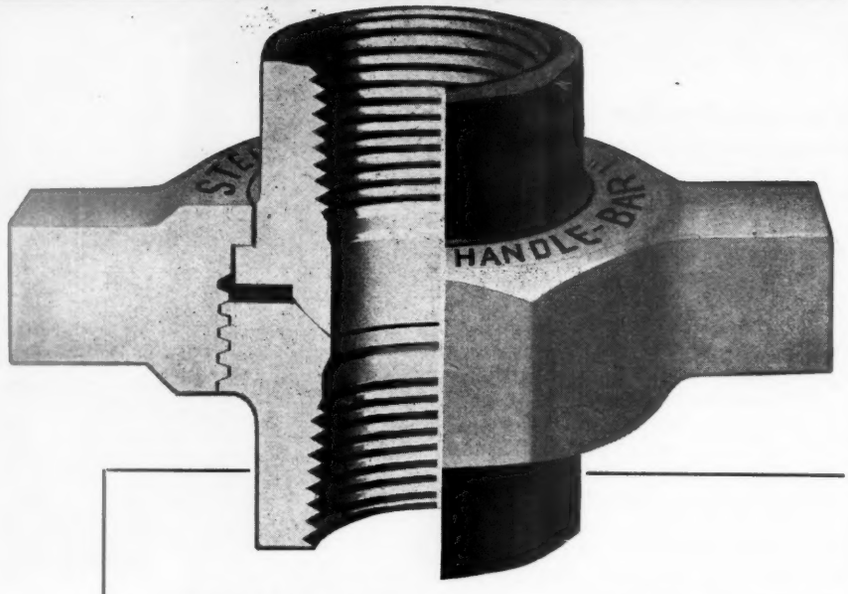
PASADENA 8, CALIFORNIA

The Tool Pusher's Best Friend

HANDLE-BAR

REG. U.S. PAT. OFF.

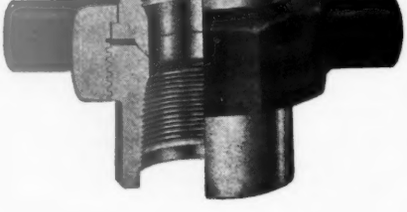
Forged Steel Unions



HANDLE-BAR 4000 TEST

REG. U. S. PAT. OFF.

HANDLE-BAR Unions are precision made and tested at time of manufacture to assure a tight seal in seats and threads. These famous features are built into each HANDLE-BAR. Integral steel to steel or bronze to bronze seats. Hub ends tapped Briggs Standard steam threads. Nut threads modified Acme. Furnished black hub ends with Udylite nut, or all rust-proof with Udylited hub ends and Parkerized nut. Recommended for all services and on pressures to 3000 lbs.



HANDLE-BAR 6000 TEST

REG. U. S. PAT. OFF.

These unions have integral steel to steel seats. The hub ends are tapped A.P.I. line pipe. The nut threads are modified Acme. The hub ends are rust-proofed and spark-proofed with Udylite Cadmium. The nut is Parkerized. These unions are recommended for all oil field services and pressures to 5000 lbs.

Write Dept. P for illustrated catalog or refer to listings in Composite Catalog pages 3140-3141, Refinery Catalog page 538, and Chemical Engineering Catalog pages 980-981.

ORDER BY TRADE NAME FROM YOUR LOCAL JOBBER

ORIGINATORS AND PIONEERS OF STEEL UNIONS SINCE 1912

CLAYTON MARK & COMPANY

1900 DEMPSTER STREET • EVANSTON, ILLINOIS

Clark Agency Establishes Texas Offices in Houston

Darwin H. Clark Company, industrial advertising agents, has opened a Houston office under the direction of Jack Rittenhouse.

Jack Rittenhouse

The agency has leased a two-story building at 1103 South Shepherd Drive, Houston, for its Texas operations. The firm's Los Angeles headquarters are situated in its own two-story building at 1139 West Sixth Street, Los Angeles. Rittenhouse for the past five years has been director of technical publications and an account executive with the Clark agency in Los Angeles.

Klingerit Name Changed

Herman Strahman, president of Klingerit, Inc., has announced that the name of the company has been changed to Strahman Valves, Inc. The trademark "Klingerit" is used on high pressure packing manufactured by Richard Klinger, Ltd. of England, for which Klingerit, Inc., have long been the United States representatives. The company, however, manfactures valves and level gages under its own name and to avoid any possible confusion, the entire activities will be conducted by Strahman Valves, Inc. The new name, however, involves no change of ownership, management or policies.

Pelton Announces New Office

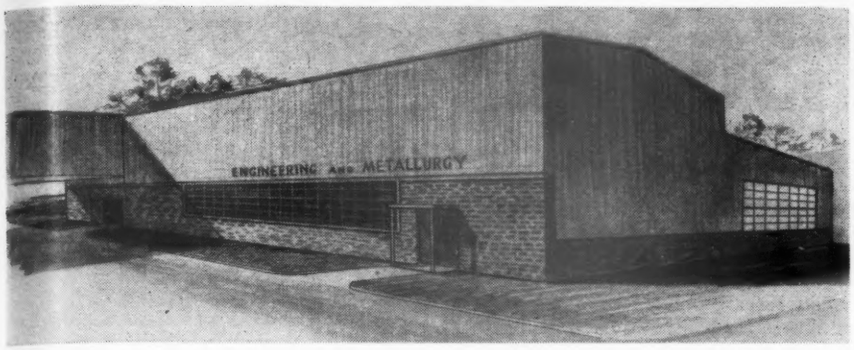
In order to handle increase in demand for Pelton long stroke hydraulic pumping jacks, C. J. Woodard, manager of the oil industry machinery division of Pelton at Los Angeles announces the opening of the new Odessa office. Complete parts and warehouse facilities, as well as 24-hour 7-day-a-week service, is being maintained.

C. J. Woodard

Managing the Odessa office is Earl Dwyer, formerly Los Angeles plant office manager. Also assigned to the Odessa staff is Gene Bell, who will work with Dwyer on sales and service.

Worthington Pump Office Set Up in Pennsylvania

Worthington Pump and Machinery Corporation, Harrison, New Jersey, has opened a branch office in Harrisburg, Pennsylvania, at 506 Hall Building, Second and Locust Streets, according to an announcement by T. J. Kehane, Worthington general sales manager. The new office will be managed by A. L. Mays and will be a branch of Worthington's Philadelphia, Pennsylvania office.



Cameron Iron Works' new engineering and metallurgical building, scheduled for completion during November. Front half of the building has two floors and houses the offices, drafting rooms, and laboratories of the engineering and metallurgical departments. Rear half of the building is single floor and includes the engineering test labs for testing equipment at both normal and high temperatures, the stress analysis lab, and the metallurgical machine shop.

Hagan Sub-Offices Are Established

Three sub-offices of the recently established Chicago district office of Hagan Corporation, Pittsburgh combustion and chemical engineering firm, have been opened. The offices also serve Hall Laboratories, Inc., Calgon, Inc., and The Buromin Company, subsidiaries of Hagan Corporation. Art Soderberg is in charge of the sub-office at Rockford, Illinois, covering the northern half of Illinois and Iowa and portions of Wisconsin. Wilf Chapman is in charge at the Peoria sub-office, serving southern Illinois and Iowa. Otto Lessa will direct the Indianapolis office, covering portions of Indiana. The Chicago district office, established February 1, 1951, is directed by Harry E. Morton.

Rainey Company Is York Sales Engineer

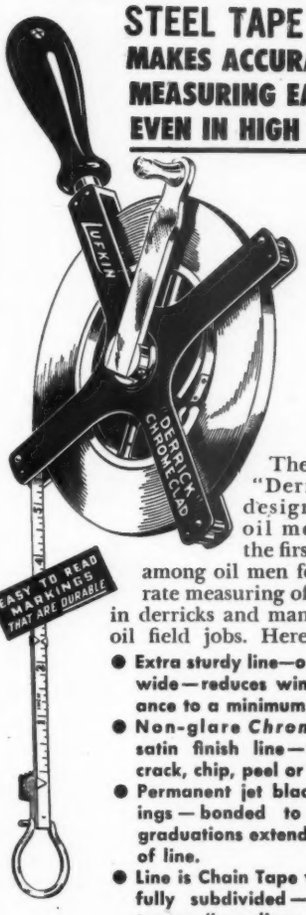
Otto H. York, president of the Otto H. York Company, Inc., process equipment manufacturers and engineers, announces the appointment of The Rainey Company, 4219 Yoakum Boulevard, Houston 6, Texas, as sales engineers for the South-Central region. Under the direction of John B. Rainey, the newly appointed organization will handle all the South-Central regional sales and engineering for the York line of wire mesh entrainment separators and mist extractors; the Scheibel-York multi-stage liquid-liquid extraction equipment for performing precise separations; the compressed wire barriers, filters, and strainers used in the petroleum and allied industries.

Richard Grayson, left, former president of Grayson-Greenamyer, Inc., looks on as William Ray, second from left, president, General Controls Company, shakes hands with John H. Grayson. Others are J. F. Ray, General Controls vice president, background, and George Greenamyer, right. The handshaking completed General Controls' purchase of Grayson-Greenamyer, Inc. Richard Grayson will take over as general manager of the newly-formed Grayson-Greenamyer appliance controls division plant, Greenamyer has been appointed works manager, and John Grayson will be retained as director of research and development.

STURDY NARROW LINE ASSURES EASIER HANDLING

LUFKIN

"DERRICK" CHROME-CLAD STEEL TAPE MAKES ACCURATE MEASURING EASY... EVEN IN HIGH WIND



The *Lufkin* "Derrick" — designed by oil men — is the first choice among oil men for accurate measuring of casings in derricks and many other oil field jobs. Here's why:

- **Extra sturdy line—only ¼-in. wide—reduces wind resistance to a minimum.**
- **Non-glare *Chrome-Clad* satin finish line—will not crack, chip, peel or corrode.**
- **Permanent jet black markings—bonded to steel—graduations extend to edge of line.**
- **Line is Chain Tape weight—fully subdivided—"Instantaneous" readings.**
- **Oversize drum increases winding speed. Long handle gives extra leverage—line locking type.**
- **Substantial, 4-arm frame has tape roller in each arm. Tape removable from frame.**
- **Improved pattern finger rings. Patented reinforcing strip prevents kinking and first end breakage.**
- **Hook is securely riveted to lip of detachable, swinging ring.**

In 100-ft., 150-ft. and 200-ft. lengths marked feet, 10ths and 100ths; or feet, inches and 8ths. See them at your Supply House.

Buy LUFKIN

TAPES • RULES • PRECISION TOOLS

THE LUFKIN RULE CO., SAGINAW, MICHIGAN

132-138 Lafayette St., New York City • Barrie, Ont.

TRADE PERSONALS

G. T. Bowman

R. B. Kitzmiller

Gilbert T. Bowman has been named sales manager of gas products for Rockwell Manufacturing Company. He will be replaced as manager of the San Francisco, California office by **Robert B. Kitzmiller.** Bowman will have his headquarters in Pittsburgh, Pennsylvania.

Bowman joined Rockwell in 1939 as a sales engineer and was assigned to the Northern California territory. He attended Manhattan College and the University of Detroit. Kitzmiller joined the company in 1934.

Dr. James F. Eversole was appointed manager of research administration of Union Carbide and Carbon Corporation. He will help co-ordinate the research activities of all of the Union Carbide laboratories where basic research and development work is being done on alloys, chemicals, gases, carbons, and plastics. Eversole joined the chemical research organization of Union Carbide as a research chemist in 1929.

Ed McWhirter of McWhirter Supply Company, Newhall, California, has been appointed distributor for the Castaic area for Black Magic oil base drilling fluid, White Magic Oil emulsion mud, OB Hevywate weighting material, and other mud products manufactured by Oil Base, Inc., Compton, California. **Courtland Parfet** has been named the agent for Oil Base, Inc., to serve Europe, Africa, and the British Isles from offices at 52, Avenue Des Champs-Elysees, Paris, France.

Alfred E. Treen has been appointed manager of personnel and purchasing at the Houston, Texas works of A. O. Smith Corporation, succeeding **F. B. Dunn** who has resigned from the company. Treen took over his responsibilities at Houston, under **C. R. Rigby,** group executive manager of the Houston plant. He has been with A. O. Smith's personnel administration staff since November, 1946, when that activity was made a top management function.

A. E. Treen

Dr. C. F. Fryling, outstanding American chemist who was a leader in the development of "cold" rubber, has joined the research department of Koppers Company, Inc. He will supervise special research projects of a pioneering nature for Koppers. Dr. Fryling was graduated from Lafayette College with a bachelor of science degree, and later obtained masters and doctors degrees from New York University. For a time he was National Research Council Fellow at Princeton University.

F. J. Bradford has been named special sales representative for Nordstrom by Rockwell Manufacturing Company. Bradford attended both the University of Kansas and the University of Oklahoma. He has had 18 years experience in selling oil field equipment and is well known in the Mid-Continent and Gulf Coast areas.

F. J. Bradford

George P. Daley, field salesman at Harvey, Louisiana, Continental Supply Company, has been appointed store manager at the same location. **Jack R. Barron,** assistant store manager at Kilgore, Texas has been appointed store manager at Palestine, Texas.

Max T. Sutton has been appointed service engineer for the Houston, Texas, office of the oil tool division, Byron Jackson Company. Sutton is a native of Mississippi, and a veteran of the last war, having served four and one-half years with the Army Air Force. He was formerly employed by Humble Oil and Refining Company.

M. T. Sutton

R. P. Bloss, has retired as general manager of the Ideco manufacturing plant at Beaumont, Texas, and will be retained as an independent executive consultant of the Ideco Division, Dresser Equipment Company. His retirement was enforced by illness, it was reported. Before joining Ideco, Bloss was for several years chief engineer of Parkersburg Rig and Reel Company. Subsequently, he was appointed chief engineer of Ideco in the fall of 1921. For many years before going to the Beaumont plant in 1936, he was vice president and general manager of Ideco-Columbus (Ohio). He will be retained in an advisory capacity.

L. L. Durkin has been transferred to the West Texas-New Mexico territory

L. L. Durkin

J. C. McCelvey

of Well Equipment Manufacturing Corporation as sales representative. **J. C. McCelvey,** formerly representative on the Gulf Coast will also transfer to West Texas and will make his headquarters in Odessa. Durkin's office will be be in Hobbs. **Harry T. Rogers** has been appointed sales representative for East Texas, North, Louisiana, and Southern Arkansas. Rogers recently completed the company's training program.

H. T. Rogers

Jeff Coats has been named sales personnel division manager of United States Steel Supply Company. A 1941 graduate of the University of Arkansas, Coats has been with the sales personnel division of United States Steel Company in Pittsburgh since 1950. Prior to joining U. S. Steel, he was vice president and general manager of Beaver Coaches, Inc.

E. D. Powers, vice president in charge of production, was elected to the board of directors, American Cyanamid Company. He succeeds **H. P. Eastman,** retired. **A. J. Campbell,** general manager of the industrial chemicals division, and **Howard Huston,** formerly assistant to the president, were elected vice presidents. **L. C. Duncan** was elected assistant to the president. Other executive changes announced were the election of **J. J. Murray** and **G. C. Walker** as assistant treasurers, and **J. W. King** and **W. B. Ward** as assistant comptrollers.

J. A. Corcoran, Ridgewood, New Jersey, has been assigned to the New York branch office of the Kaylo Division, Owens-Illinois Glass Company. He will report to Dave Innes, New York branch manager. Corcoran began representing the Kaylo Division in the sale of its hydrous calcium silicate heat insulating and building products on August 1. He was employed by Owens-Illinois on May 7 and was trained in the division's manufacturing and sales departments until his assignment.

J. A. Corcoran

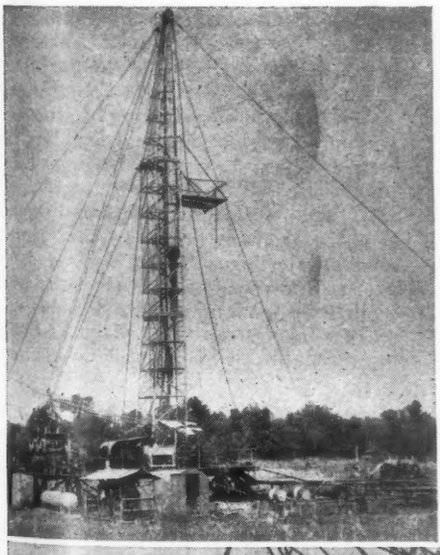
R. H. Cramer, general manager of the Hyatt Bearings division of General Motors Corporation has announced that preliminary plans are now complete for expansion of the manufacturing areas in the Hyatt plants in both Harrison and Clark Township, New Jersey. Increasing demand for roller bearings in the National Defense Program has necessitated this expansion of manufacturing facilities. New structures at the Clark Township plant will provide an additional 390,00 sq ft of floor space doubling the existing facilities.

Richard L. Lauderdale, sales engineer of Builders-Providence, Inc., has joined the engineering sales staff of Builders-Pacific, Inc., Berkeley, California. Lauderdale is a graduate of the University of Oklahoma.

Walter H. Brown has been transferred to the projects department of Builders-Providence, Inc., and will specialize in equipment applications for sewage and industrial waste treatment. Previously he was a sales engineer in Builders' standard and engineered products department.

Claude H. Groom, of Dowell Incorporated, has been promoted to assistant sales development manager. Groom, who has been associated with Dowell and its parent organization, The Dow Chemical Company, since 1936, formerly was a development engineer in Dowell's industrial division. In 1936 Groom joined The Dow Chemical Company staff in the organic research laboratories in Midland, Michigan. Later that same year Groom was assigned to Dowell research problems, then being handled through Dow Laboratories.

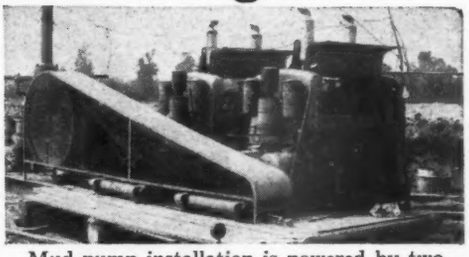
Lane-Wells Company management, sales, engineering, and operating representatives gathered recently in Houston, Texas, for a two-day conference to discuss sales and operations. On hand to present current and future plans of the company were Rodney S. Durkee, president; James D. Hughes, general sales manager; and Morton T. Higgs, manager of field operations. The sessions were supervised by John J. Neale, Gulf Coast division manager, and R. M. Rutledge, Jr., Gulf Coast sales manager.



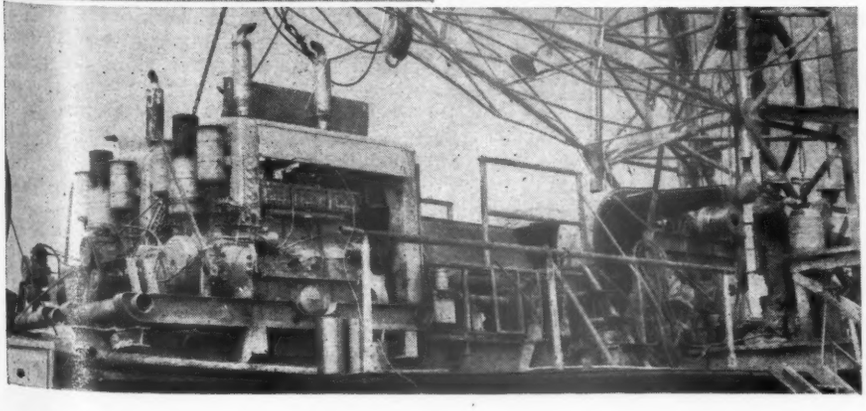
Beene-Hurley Use Low Cost Power on Frank's Rig!

Drillers Beene and Hurley at Bossier City, La., use Frank's portable rig with four Minneapolis-Moline 1210-12A units for power. They are drilling low-cost wells to depths of 6500 feet. The 1210-12A, 12 cylinder unit engines are factory equipped to operate on LP gas or natural gas—the low priced fuels in this area.

Beene and Hurley have mounted two of these units on the drilling table to furnish power to the draw works. These engines are equipped with front power take-off drives and supply 400 hp with LP gas. The other 1210-12A units are remotely located on the mud pump. The complete engineering and installation was done by Beene and Hurley at Shreveport.



Mud pump installation is powered by two MM 1210-12A's.



Two MM 1210-12 on the drilling table operate on low-cost, higher octane LP gas.

This arrangement combines flexibility of layout with important time saving for setting up the rig. Precision tooling and high production methods account for the extremely low selling price of MM heavy-duty oil field power units. Standardization of parts permits interchangeability which assures easier, lower-cost maintenance.

Sales and service of MM oil field engines are handled by the Shrimpton Manufacturing and Supply Co., with branches at Los Angeles, California; Oklahoma City, Oklahoma; and Kilgore, Texas.

▸ **John E. Brock** has been appointed director of research for Midwest Piping and Supply Company, Inc. He will make his headquarters at the main plant and executive office in St. Louis, Missouri. Brock brings to his new position a broad background of industrial research. He investigated the mechanical properties of plastic ceramic bodies while with the Westinghouse Research Laboratories. He is a graduate of Purdue University.

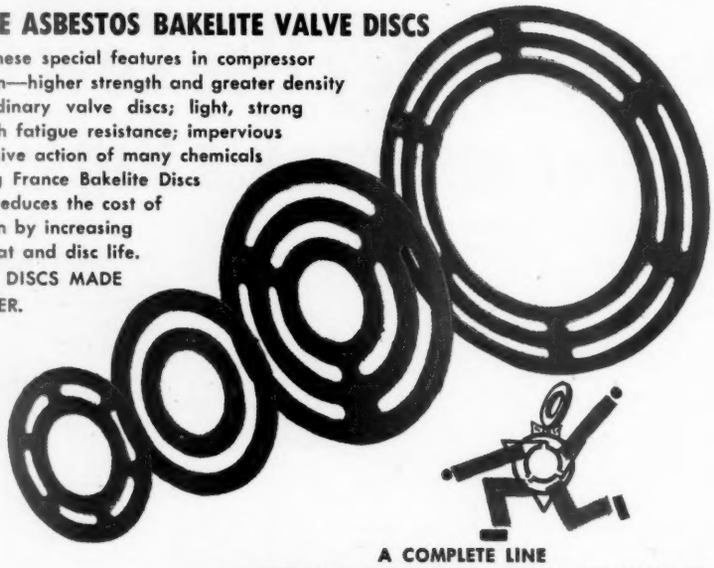
J. E. Brock

▸ **Henry B. Safford, Jr.,** has been appointed to the position of advertising and sales promotion manager of the General Controls Company of Glendale, California. Safford, who was graduated from Dartmouth College in 1938, came to the company from New York City where he was a partner in a creative advertising services concern. Safford's primary duty will be to oversee, produce, and originate silent sales aids to augment the field work done by the sales representatives. For two years, 1947 to 1949, Safford served as advertising manager and European sales manager of the "British Magazine" in London and Paris. Prior to that he was with Lehigh Portland Cement.

BAKELITE VALVE DISCS

FRANCE ASBESTOS BAKELITE VALVE DISCS

assure these special features in compressor operation—higher strength and greater density than ordinary valve discs; light, strong with high fatigue resistance; impervious to corrosive action of many chemicals . . . Using France Bakelite Discs greatly reduces the cost of operation by increasing valve seat and disc life. SPECIAL DISCS MADE TO ORDER.



A COMPLETE LINE
OF PACKINGS AND PISTON RINGS FOR INDUSTRY

FRANCE PACKING CO.
PHILA. 35, PA.

▸ **Jim G. Spalding,** a University of Oklahoma petroleum engineer graduate, has joined Otis Pressure Control Export Corporation as sales and service engineer for Canada. He will be stationed at Otis' newly-established office in Calgary. Spalding formerly was with Mene Grande in Venezuela. After returning to the States he spent several months working out of the Otis division offices in New Iberia and Odessa.

J. G. Spalding

▸ **H. E. Schrader** has been promoted to the executive staff of Western Gear Works. In his new duties, Schrader will assist **B. A. Bannan,** vice president, in product development and research for Western Gear Works plants in Lynwood, Belmont, and Seattle; Pacific Gear and Tool Works of San Francisco, and South Western Gear Works of Houston. Schrader has been with the company for 23 years, and was formerly in charge of design and application engineering for the Lynwood plant of Western Gear. His offices will be in Lynwood.

H. E. Schrader

▸ **J. S. Fluor,** executive vice president of the Fluor Corporation, Ltd., Los Angeles, has been elected to the executive committee of the National Constructors Association, an organization of firms engaging in engineering and building of oil refineries, steel mills, and chemical plants. He will serve until the end of 1952. Fluor joined his father and brother in the company that bears their name in 1921. He began in the field on engineering and construction projects, and in 1929 he was appointed assistant general manager and vice president, assuming the duties of his present position in 1945.

▸ **G. F. Vietor, Jr.,** has been appointed a district manager of Air Reduction Magnolia Company, a division of Air Reduction Company, Inc. Vietor will make headquarters at Houston, Texas, where he will have sales responsibility for the Houston district, with branch offices at San Antonio, Beaumont, and Corpus Christi, Texas. Vietor is a graduate of Yale University and joined Air Reduction in 1939. He served 5 years in the U. S. Navy and was discharged in 1946. He returned to Airco and was later named assistant manager of the Boston district.

G. F. Vietor, Jr.

E. F. "Gene" Shiels has been named domestic sales manager of Dresser Equipment Company's IDECO division. An engineering graduate of Texas A and M College, Shiels joined IDECO as a sales engineer in 1946. He has been

E. F. Shiels

G. G. Wilbur

technical service manager in the Dallas headquarters. **Gordon G. Wilbur** has been named assistant export sales manager. He is a graduate of Oklahoma University, and during the last 12 years has filled various key positions in the sales, technical service, and export divisions of IDECO.

Dan Duncan has been named research engineer for IDECO's oilfield division. Almost 30 years experience in the oil industry has qualified Duncan for his new position. He will work under the direction of IDECO'S Dallas, Texas office.

William B. Pierce has been elected a vice president of Allegheny Ludlum Steel Corporation. Pierce, who joined the company in 1945 as manager of the sales development and engineering service department, was named technical director in December 1950, when he was given responsibility for research and metallurgical activities. He will retain that position as a vice president. Pierce has been active in metallurgical research since 1929 when he was graduated from the University of Illinois and took a position with Aluminum Company of America. Headquarters of the newly elected vice president will be established in the company's new research laboratory soon to be opened at Brackenridge, Pennsylvania.

Dr. Raymond C. Machler has been named director of research and a member of the executive committee of Leeds and Northrup Company. He succeeds **I. Melville Stein,** who recently was elected to the newly created post of executive vice president. Charles S. Redding, president, announced the appointments.

R. C. Machler

Redding also announced that **J. C. Peters,** associate director of research will be joined in that capacity by **G. A. Perley** and **A. J. Williams, Jr.** Both formerly were assistants to the director in the company's research department.

Harold R. Fosnot has been named Eastern sales manager with headquarters at the company's home office, New York City. Fosnot, who has been with Graver since 1935, is a graduate of Purdue University and the University of Chicago. He has been Chicago district manager since 1937. Replacing Fosnot as the Graver Chicago district manager, will be **Herman M. Ross,** who had previously been the Cleveland district manager. In Cleveland, Graver will be represented by **Richard E. Lewis,** who was previously in the Graver home office.

Joseph B. Marz has been named representative on the Gulf Coast area by Manzel, manufacturer of lubricators and chemical feeders. Marz has had much experience in the oil fields and is well equipped to serve the production men of the industry. He served as a radioman aboard a U. S. Navy destroyer, and has more recently been associated with Sinclair Oil and Gas, and Fish Constructors of Houston.

J. B. Marz

Ben C. Sargent, Jr., has been named South American representative for the Lufkin Foundry and Machine Company. He will spend about 60 days in New York City, working directly with **A. V. Simonson,** export manager for the company. Sargent has had three years training in the oil fields of Texas and Arkansas. He was an employee of the California branch of Lufkin Foundry before entering the military service.

B. C. Sargent, Jr.

W. J. Lytle has been appointed manager of the Permian Basin division, Schlumberger Well Surveying Corporation. He replaces **A. Morazzani** who recently transferred to Indiana as manager of the company's Northeast Area. **R. L. Morris** is transferring to Houston, Texas from Lafayette, Louisiana to become administrative assistant to **J. de Menil,** president of the Affiliated South American Schlumberger Companies. **W. W. Goode** will replace Morris as division manager of the Louisiana Gulf Coast Division.

H. W. True

F. P. Kokesh, division manager of the Mississippi division is transferring to the engineering department in Houston, and being replaced in Jackson, Mississippi, by **H. W. True.** True was formerly district manager in Houston.

Wayne L. Moore has recently joined Technical Oil Tool Corporation, Ltd., and will be stationed in the Houston, Texas area. **A. B. "Al" Sanders** has also been added to the Totco staff, and will be stationed in Odessa. With these men,

W. L. Moore

A. B. Sanders

Totco now has six engineers under R. L. O'Rear, Gulf Coast division manager, and 8 engineers under the direction of F. E. Siever, to serve the West Texas division. E. G. McConnell is in charge of the 23 representatives servicing the Mid-Continent area.

O. E. McCullough, Jr., and **E. C. Vierling, Jr.,** have been named assistant managers of the protective coatings division, Pittsburgh Coke and Chemical Company, Pittsburgh, Pennsylvania. They will be responsible for directing and coordinating the division's expanding sales, production, technical service, and development activities. McCullough will be associated with the tar base coatings and Vierling with the synthetic base coatings. McCullough came from Dallas, Texas where he had his own oil business. He studied geology at Southern Methodist University. Vierling attended Carnegie Institute.

W. Cordes Snyder, Jr., of Sewickley, Pennsylvania, has been elected president and chief executive officer of Blaw-Knox Company. He previously was a vice president of the company in charge of its Lewis foundry and machine division, and more recently has been vice president of the Koppers Company and manager of its metallurgical department. Snyder is expected to assume his duties with the Blaw-Knox Company on or about November 1, 1951.

J. L. Mohun has been named division manager, industrial insulation sales, for the Baldwin-Hill Company. He will be situated at the new sales office established by Baldwin-Hill at 4101 San Jacinto Street, Houston, Texas. The appointment of Mohun, in conjunction with the recent purchase by the Baldwin-Hill Company of the Tex-Rock Insulation Manufacturing Company of Temple, Texas, will enable the Southwest to be served better with such materials as insulating blankets, felts, insulating cements, pipe insulation, etc.

J. L. Mohun

Bruce M. Williams is now sales engineer with the John A. Green Company, Dallas, Texas. In his new position he will call on industrial accounts, jobbers, research laboratories, and manufacturers in the states of Texas, Oklahoma, Louisiana, Arkansas, and New Mexico. The John A. Green Company is sales engineering representative for several nationally known manufacturers of test instruments, complete electrical equipment, and quality component parts. Williams attended the University of Cincinnati and Oklahoma A. & M. College, receiving his BS and MS degrees at these respective schools.

B. M. Williams

Robert R. Shackelford has been named a district sales engineer for Oklahoma, by Merla Tool Corporation, Dallas, Texas. Shackelford specialized in gas lift engineering and is a graduate of Oklahoma University. His headquarters will be in Oklahoma City. At the same time, it was announced that **Robert C. Warren, Jr.,** has been appointed as sales engineer in the East Texas and Northern Louisiana area. Warren, a graduate of Texas A & M, will temporarily be stationed in Shreveport.

John B. Madden has been appointed hydraulic sales manager for the North central district of A. O. Smith Corporation, with offices at 310 South Michigan Avenue. Madden, former product supervisor, originally operated hydraulic sales from A. O. Smith's Houston works, where the firm's vertical turbine pump manufacturing is centered. Madden's appointment will permit **Hal Kern,** former district pump sales manager, to give more concentrated attention to distributor accounts in the field.

J. B. Madden

Ray E. Carter has been named president of Unit Rig and Equipment Company of Tulsa, Oklahoma. He succeeds **William Guier** who has resigned. The appointment was made in agreement with an understanding at the time Unit Rig stock was sold to K. W. Davis of Fort Worth, Texas. Guier agreed to continue with the company for a period of time after which Carter would be president.

Charles C. Buckland has been elected a vice president of Minneapolis-Honeywell Regulator Company. A director and secretary of the company, Buckland also will head a newly created sub-contracting division that will correlate and expand sub-contracting activities of the aeronautical and ordnance defense programs.

Glenn Seidel, who has been assistant to the vice president in charge of engineering, has been appointed to the newly-created post of director of ordnance. Another new post—superintendent of ordnance—will be filled by **Stanley J. Nelson,** superintendent of manufacturing. Other appointments resulting from the growth of the company's aeronautical division include: **E. H. Salzman,** formerly assistant director of the division, to director of aeronautical administration. **M. P. Fedders,** formerly works manager of M-H, to manager of aeronautical operations. **Howard J. Stoops,** formerly manager of administration, to director of manufacturing.

A. P. (Joe) Wells has been appointed division manager for Arkansas, Louisiana, Mississippi, and East Texas for the American Iron and Machine Works Company, Oklahoma City. His headquarters will be in Shreveport, Louisiana. Wells attended Louisiana State University. He spent five years for the National Supply Company and five years for Oil Well Supply Company. Since joining the American Iron sales organization in 1949, he has been assistant district manager in West Texas.

A. P. Wells

THE PIONEER OF
SELF-MOTIVATED SEPARATORS

- PROVEN PERFORMANCE
- ECONOMICAL OPERATION
- SAVES DRILLING COSTS

No drilling outfit should be without a Thompson Shale Separator and Sample Machine. The Thompson Separator does a twofold job: (1) it removes the shale and abrasives from valuable drilling mud, and (2) the amazingly accurate SAMPLE MACHINE collects cuttings all the time the separator is operating to give an accurate foot-by-foot analysis of the progress of the well. The value and accuracy of the Sample Machine is recognized by drilling and geologic authorities as the best method of obtaining samples.

Try THOMPSON, You'll See . . .

SOLD THROUGH SUPPLY STORES EVERYWHERE!

THOMPSON TOOL CO.

IOWA PARK, TEXAS

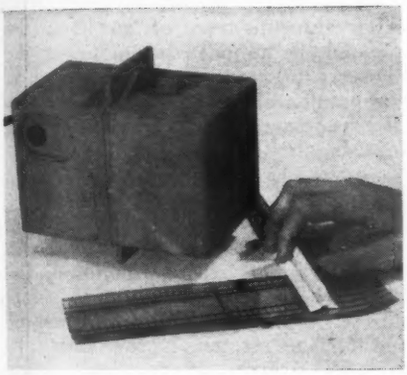
New Machinery and Supplies

Use reply card to procure promptly complete information and prices of products described here in brief.

Circle corresponding letter or letters on reply card.

(A) OSCILLOGRAPH

Up to nine sources of data representing vibration, pressure, velocity, strain, or other phenomena, either static or dynamic, can record simultaneously on the new 5 by 5 by 8-in. recording oscillograph, just released by Consolidated Engineering Corporation. Operating



from a 28-volt d-c power source, this highly compact test instrument is ideally suited to mobile testing programs, where space and weight saving are important. Completely light-tight, the magazine separates from the oscillograph and can be handled freely without danger of film fogging. It contains the entire record transport system, which drives the film past the optical system at precisely measured rates. Power connection for the drive motor is made automatically by a built-in connector when the magazine is attached.

Circle letter (A) on reply card.

(B) OIL FLUOROSCOPE

Rotary Engineering and Manufacturing Company, Inc., has announced a new portable oil fluoroscope. The detector shows fluorescence on all types of liquid hydrocarbons from low gravity crude to distillates. Difference between mineral and oil fluorescence is determined by cutting some of the fluorescent cuttings with solvent and examining them immediately with the fluoroscope. If fluorescence is due to oil, milky oil fluorescence emergences from cuttings. The Rotary fluoroscope is designed to be used in conjunction with microscope for "one-operation" examination of well cuttings. The instrument, which weighs 13 lb, detects high gravity oils, often confused with mineral fluorescence under ordinary procedure.

Circle letter (B) on reply card.

(C) SPUR GEAR

The Coffing Hoist Company has announced a new spur-gear hoist, now in production in ½ and 1-ton capacities. Called the Challenger, the entire unit, including standard length of high-strength coil chain for an 8 ft lift. weighs only 39½ lb, thus is easily moved from one place to another, as needed. Strength and unusual resistance to shock-load breakage are said to be gained by the use of formed steel plate in the housing in place of cast aluminum alloy. The back plate is laminated to give extra rigidity for supporting the hoist mechanism. It is said to be sealed and running in lubricant.

Circle letter (C) on reply card.

(D) JET PERFORATING

A new service, known as the Jeep-Jet perforating service, has been announced by Welex Jet Services, Inc. Jeep-Jet perforating makes use of the new twin-jet charge, which is based on the same shaped charge principles as the original jet perforating process developed by Welex, but is different in some of its details of design. The Jeep-Jet perforating service is not a substitute for the regular Welex Jet perforating, as the penetration is not quite as great as the regular jets. Jeep-Jet perforating, however, does offer the operator many advantages over bullet perforating, and is priced exactly the same as bullet perforating.

Circle letter (D) on reply card.

(E) HOLE SHOOTING

Perforating service employing a new development, the Glass Gun, is now available in the West Texas and New Mexico area, by Dowell Incorporated, Midland, Texas. Dowell Perfo-Jet service has not been available in the Midland district prior to the development of the Glass Gun. The new Glass Gun, developed by Dowell, is a self-destroying gun which allows the use of a larger explosive charge than do other types of guns. It is being used to good effect both in casing perforating and in open hole shooting. It consists of glass-enclosed, shaped charges in an expendable aluminum carrier and can be tailor-made to fit a wide variety of shooting patterns and hole diameters. One of the advantages of the Glass Gun is that it leaves a junk free hole.

Circle letter (E) on reply card.

(F) WIRE LINE GUIDE

A new wire line guide now available to rig operators hydraulically absorbs the whip and lash of the line encountered in drilling operations. The new Collins hydraulic wire line guide reduces wire line wear by hydraulically absorbing whip and lash as line spools on and off drawworks drum at high speeds. It allows the line to spool evenly at highest speeds, preventing drum crushing, dog legs, and line kinking.

Circle letter (F) on reply card.

(G) PACKERS

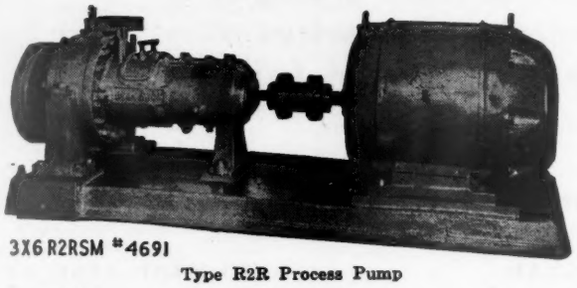
A new hold down packer with an automatic latch, Type "AHD," is now in production at the Dallas, Texas, factory of the Guiberson Corporation. The new packer was designed for acidizing or injecting fluids into formations below the packer, and any other job where tubing pressure is greater than annulus pressure. According to Guiberson officials, Type "AHD" sets equally well at 1000 to 10,000 ft. An automatic latch is incorporated in the Type "AHD." The all-metal latching dog and corrosion-resistant springs plus the anti-lock mechanism assure the operator positive control of slips when setting or pulling. A telescoping valve that equalizes tubing and casing fluid assures easy running.

Workover operations using the Hydra-frac process showed the Type "AHD" holding pressures over 3000 psi and localizing the fluid until the treatment was completed. The tests indicated that the special "AHD" thick-walled packer cups made a good initial seal and retained the seal throughout the operation.

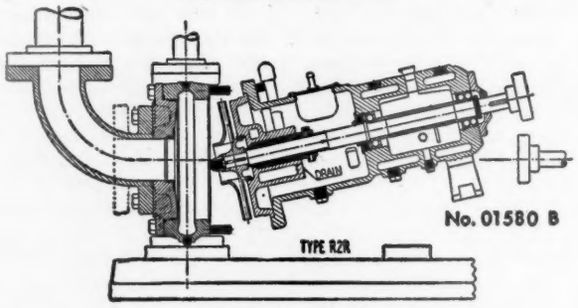
Circle letter (G) on reply card.

DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

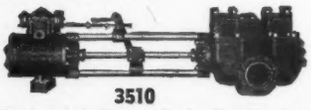
OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.

Capacities: 50 to 2000 Gallons per minute. **Heads:** Up to 400'. **Speeds:** 900 RPM to 4060 RPM.

BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL and RECIPROCATING PUMPS

Close Coupled Centrifugal Pump

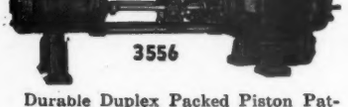


Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

Pedestal Mounted Centrifugal Pump

Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump

Double Pedestal Bearing Centrifugal Pump



Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W TENTH ST.

Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS

Representatives in Principal Cities

(H) CONTROL INSTRUMENT

A new instrument that provides sensitive, instantaneous, and accurate control of flow, temperature, pressure, liquid level, and other industrial process variables has been developed by Minneapolis-Honeywell Regulator Company. The device, the Tel-O-Set controller, is described by the company as the latest component in a series of a new devices designed to improve process control. The new model is made in two types, one with fixed proportional band, the other with adjustable proportional band. The units are constructed of a number of coded, interchangeable sections separated by diaphragms.

Circle letter (H) on reply card.

(I) SOLVENT CLEANER

A new emulsion solvent cleaner to soften the paraffin in well tubing has been developed. In practice 10 gal of Magnusol concentrate are mixed with 60 gal of kerosine and the resulting solution is then poured down the tube. After three-quarters of an hour, the paraffin is softened enough for the scrapers to go to work. Magnusol in the paraffin eliminates the trouble usually associated with this type of crude oil. Magnus Chemical Company.

Circle letter (I) on reply card.

(J) SCRAPER

A new scraper has been announced by the Tractor Sales Corporation, distributors for Leland T. McGee angledozers. Among the unique features of the McGee scraper is the ability to back-fill, scarify, grade (both rough and finish), and various other scraping uses. The McGee scraper is the only scraper with cradle action and a revolutionary hydraulic upper-link control. This hydraulic control is the first time hydraulic control of scraping angle has ever been applied to a scraper. The operator, with but a touch of the control valve adjusts the tilt of the scraper. The tilt can be changed for scraping, backfilling, scarifying, without dismounting.

Circle letter (J) on reply card.

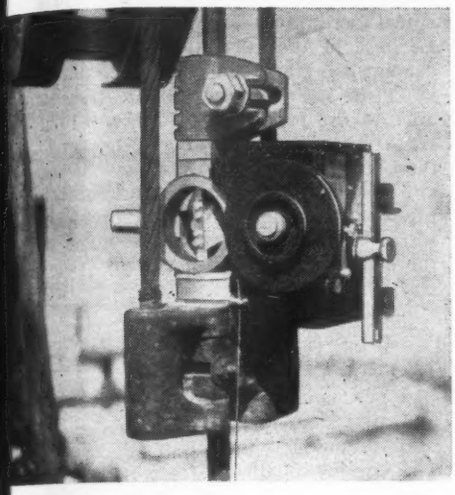
(K) ANTI-FRICTION BEARINGS

To overcome certain technical limitations of nylon in bearings, Thomas Industries, Incorporated, has developed the Nylined bearing. A typical Nylined bearing consists of an outer sleeve of inexpensive metal and a relatively thin lining of nylon bearing material. The nylon liner is retained in the outer sleeve in a manner that will permit it to expand and contract circumferentially around the inner periphery of the outer sleeve. The liner is provided with a narrow slot, or compensation gap, which interrupts the circumference. In applications where lubricants can be used, one or more annular grooves are provided on the inside of the outer sleeve to form storage wells for grease or other lubricants that are evenly distributed through the compensation gap.

Circle letter (K) on reply card.

(L) DYNAMOMETERS

A new dynamometer used for operational control of pumping wells was recently put on the market. By calculating the deflection of a steel proving ring, it measures and records the pump-



ing load at every point in the stroke; measures counterbalance effect at the polished rod. It tells when the traveling valve in the pump opens on the down stroke; gives an indication of the working fluid level, the weight of the fluid and the stability of the pumping operation. The J-F Dynamometer records unnecessary loads, which are the cause for a substantial number of mechanical failures. Johnson-Fagg Engineering Company.

Circle letter (L) on reply card.

(M) TWO-WAY RADIO

A new low-power 2-way radio that utilizes the Uni-Channel Sensicon receiver has been designed by Motorola. The unit meets FCC regulations that allow a maximum power input of 3-watts to the final amplifier for those industries where all 2-way radio communications are carried on within a single plant area. The low-power Uni-Channels can be installed, either as base stations or as mobile units. They can be mounted and used on fork-lift trucks or other intra-plant vehicles. These small, compact transmitter - receiver units are available either as a single package with built-in speaker and control head, or with individual speaker and control head. Motorola Corporation.

Circle letter (M) on reply card.

(N) FLOW METER

A new mercuryless flow meter, said to feature fast speed of response for flow control and continuous range adjustment from 0-20 to 0-200 in. of water, is described in a 16-page catalog. Operating principles of this pneumatic-balance type flow transmitter are covered, as well as construction features, typical applications, detailed specifications, and installation methods. Minneapolis-Honeywell Regulator Company, Industrial Division.

Circle letter (N) on reply card.

(O) COMPRESSION GASKETS

Several improvements designed to prolong engine life and further reduce upkeep of General Motors Series 71 diesels are announced by Detroit Diesel Engine Division. Chief among these newly designed features is a revolutionary method of oil, water, and compression sealing between the engine block and head that does away with the laminated gasket commonly used in internal combustion engines. The most difficult task of cylinder head-to-block gasketing is compression sealing. Detroit Diesel, through the adoption of individual seals designed to place primary emphasis upon *compression* sealing and secondary but sufficient emphasis on sealing the oil and water passages, has accomplished both in a new way. Compression gaskets, in the form of laminated Terne Plate rings, take the major pressure of the head-to-block stud bolts. A small "skirt" on each compression gasket ring fits into a recess between the cylinder liner and the cylinder bore in the block, assuring a correct positioning over the cylinder line. General Motors Corporation.

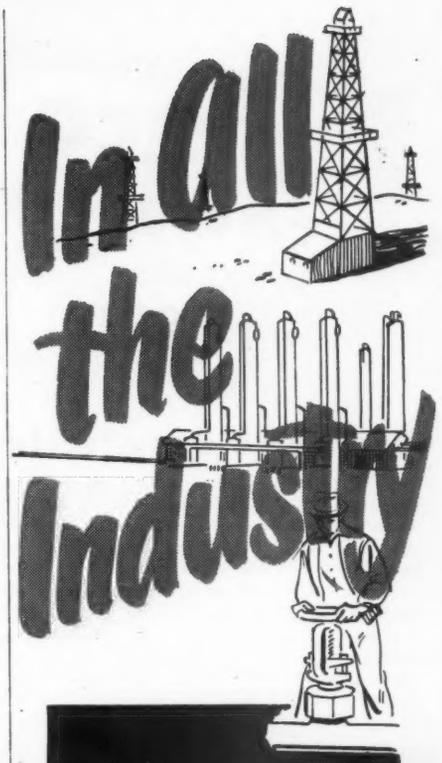
Circle letter (O) on reply card.

(P) TRANSFORMER WELDER

Air Reduction Magnolia Company, a division of Air Reduction Company, Inc., has announced a new 200 ampere transformer welder. The Airco Model MCM 200 ampere transformer welder is designed for general maintenance and

production welding. It's a rugged unit with easy-to-operate controls and is built for long, dependable service in garages, job shops, and industrial plants. The MCM has a full 200 ampere, 50 per cent duty cycle, NEMA rating. Four variations are available—220 volt or a 220/440/550 volt unit, each with or without power factor correction. Two open circuit voltages are provided—80 volts on the low range and 55 volts on the high range. This combines easy arc starting with a lower KVA demand load and primary ampere current.

Circle letter (P) on reply card.



where a single failure can **CRIPPLE PRODUCTION...**

Inspection with Magnaflux safeguards operations against interruption—or disaster.

Magnaflux is the modern, standard way of finding defects in critical parts and equipment. It finds tiny flaws and cracks even though invisibly small or hidden beneath the surface!

In reactors, tanks and pressure vessels—in pipe line pumping stations and drilling equipment—regular inspection with Magnaflux "spots" cracks that develop in welds, castings, pumps, etc. Wherever equipment is subject to strain or fatigue, from drilling rig to refinery—in a hundred different places—non-destructive inspection with Magnaflux prevents failure before it occurs.

Write for illustrated booklet describing how Magnaflux works . . . what it offers you. No obligation, of course!

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OCECO
Emergency
pressure relief
Vents

prevent explosions

These units provide additional venting capacity beyond the breather vent, and give instant relief from excessive internal pressures resulting from exposure fires, etc., preventing tank blow-ups and explosions.

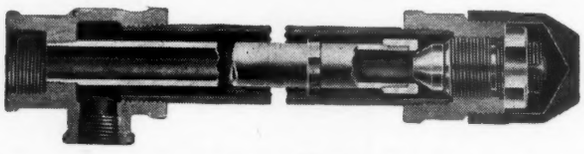
Required by many state fire codes. Recommended by both the N. F. P. A. and A. P. I.

The V-108 with cast aluminum cover, pictured at the top, furnished in 6", 8" and 10" sizes; V-108-A with fabricated aluminum cover, pictured below, furnished in 15¼" and 20½" sizes. *Write for full details today.*

OCECO TANK FITTINGS
THE JOHNSTON & JENNINGS CO.
division of PETTIBONE MULLIKEN CORP.
4751 West Division St. • Chicago 51, Illinois

NOT 1 CENT for Repair Parts for 444 Nicholson Steam Traps Installed in 2 Years

Here is added evidence of the remarkably low maintenance costs of Nicholson expansion steam traps. In the 2 years Bradshaw & Co. have been distributing them in the Pittsburgh area they have installed 444 traps. But they have received not one order for repair parts. And examination of traps in continuous drainage service for at least 18 months, at steam pressures to 250 lbs., showed no sign of valve cutting.



Pressure: 0 to 250 lbs. without change of valve or seat. Length: 18" to 40", 2 types: thermostatic, continuous flow.

Easily Installed, Low Cost

Because valve is easily adjusted to pass condensate at any temperature below 212° F., these traps are also widely used for regulating temperature of equipment.

FOR ALL EQUIPMENT Using Steam or Hot Water

Agitators	Radiators
Crystallizers	Retorts
Dryers	Steam Stills
Evaporators	Sterilizers
Heat Exchangers	Storage Tanks
Kettles	Washers
Pipe Coils	Water Stills

CATALOG 751
or see Sweet's

W. H. NICHOLSON & CO., 217 Oregon St., Wilkes-Barre, Pa.

(Q) JOINT WRAP

The Electro Chemical Engineering and Manufacturing Company announces the development of a new type wrapped joint for Haveg and other resin-base pipe, known as the Duro-Joint. The Duro-Joint is composed of a spiral wrapping of glass cloth and Lecite acid and alkali-proof furan resin cement using a special technique and is equal in strength and chemical resistance to the pipe itself. The Duro-Joint replaces in many instances, the flange type joint, which is subject to corrosion, and also may be used to repair broken pipe or to armor porcelain or stoneware. The Duro-Joint can be made in the field without the use of heat or special equipment.

Circle letter (Q) on reply card.

(R) PLASTIC SEALER

A new compound for sealing gaskets and threaded joints of all types has been announced by the manufacturer. The product, called Graycote, is composed of six basic ingredients, chief of which is a spongy metallic pigment locked in a new type of insoluble vehicle. Retention in the non-drying vehicle keeps the compound soft, creating a permanent seal but allowing units to be easily disassembled after long periods of time even under high temperature conditions. Graycote also lubricates threads to reduce wrench torque and allow additional takeup. Graycote is recommended for all oil, water, steam, gaseous fuel and refrigerant applications. Chicago Gasket Company.

Circle letter (R) on reply card.

(T) PROCESSING PUMP

A new oil-lubricated bearing, pedestal-mounted pump for handling chemicals, liquors, corrosive materials and solutions, hot liquids, and petroleum has been announced by Allis-Chalmers Manufacturing Company. The liquid end of the pump is a complete self-contained unit. The pedestal is of cast iron construction with two anti-friction bearings supporting the pump shaft. Two sizes of pedestal assembly cover the entire range of pump sizes available in capacities to 1200 gal per minute at heads to 250 ft and temperatures to 500 F.

Circle letter (S) on reply card.

(S) VISCOSITY METER

Recently improved is a viscosimeter used for determining the viscosity of bottom hole and surface fluid samples from oil wells. Made by Ruska Instrument Corporation, the viscosimeter is a rolling ball type unit for determining viscosity at pressures and temperatures up to 10,000 psi and 350 F. The roll time of the ball is automatically measured by an electric stop clock. A measuring barrel made from ⅜ in. by .065 type 304 Carpenter stainless tubing contains the stainless ball. The barrel is honed and lapped to a mirror finish; the ball is then inserted.

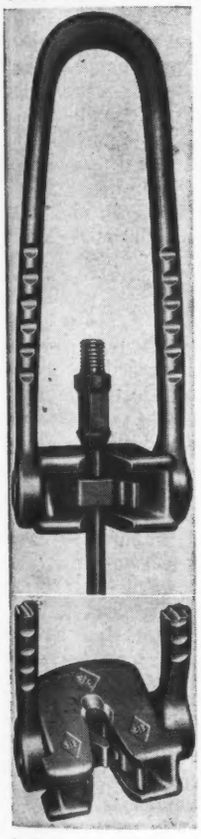
Circle Letter (T) on reply card.

(U) STEAM TURBINES

General Electric Company has announced a newly-designed line of multi-stage, mechanical-drive turbines in ratings from 200 to 5000 hp. They are designated as Types DP, DR, DRV, and DRVX. The Type DP turbine, rated from 200 to 3000 hp is designed for driving pumps, compressors, fans, blowers, etc. The Type DR turbine, rated from 200 to 5000 hp, is built for applications requiring wider speed range, greater accuracy of control than the Type DP turbine. The Type DRV rated from 200-5000 hp utilizes automatic sectional valves linked to the oil relay governor, minimizing throttling losses under fluctuating load factors and improves overall heat cycle efficiency. The DRVX is designed for applications where process steam is desired at a steady pressure.

Circle letter (U) on reply card.

(V) ROD ELEVATORS



Web Wilson Oil Tools, Inc., has developed elevators for fast handling of sucker rods and polished rods, without the danger of kinking, distortion, or dropping the string. These elevators are streamlined, with no protruding latches; the rod seats are accurately machined to fit the contour of the rod; they are properly balanced to suspend the rod string vertically, and the forged bail is reinforced at the top where extra strength is needed. Web Wilson rod elevators are instantly reversible, and in service the rod enters easily into the throat of the elevator where it is automatically locked in place and can be released only when the latch is opened by the operator. Combination sizes are available for 5/8-3/4 in., 3/4-7/8 in., and for 7/8-1 in. rods, each of 20-ton capacity.

Circle letter (V) on reply card.

(W) SWING JOINTS

Development of a new line of swing joints which are particularly applicable to gasoline and oil tank car or truck loading and unloading lines is announced by Barco Manufacturing Company. The particular advantage of the new design is its simplicity in providing for 360 deg rotation around the axis of the joint with a long bearing surface to support the weight of normal piping.

Circle letter (W) on reply card.

STOP *Vapor Losses*

with OCECO "Type B" VENT UNITS

● Combined flame arrestor and conservation vent valve. These units protect both the tank and tank contents from entrance of flame; control and restrict tank breathing and prevent the free escape of vaporized liquids and lowering of gravity ratings. Sturdy, dependable, efficient and trouble-free Oceco construction. 2" to 10" sizes. *Write for Catalog 474-R. It gives full details.*

OCECO TANK FITTINGS

THE JOHNSTON & JENNINGS CO.

division of PETTIBONE MULLIKEN CORP.

4751 West Division St. • Chicago 51, Illinois

This Pump GETS Going . . . STAYS Going In ALL Weather

It's WISCONSIN-Powered!

Sand storms or rain, cold weather or hot, this gathering pump delivers dependability at a Texas oil field. It's powered by a Wisconsin Heavy-Duty Air-Cooled Engine.

Wisconsin-powered units *get going* and *stay going* even with weather and climate against them because of such heavy-duty features as tapered roller bearings at both ends of the crankshaft, and an easily-serviced OUTSIDE magneto with impulse coupling for fast starting and steady going. And because Wisconsins are cooled by air alone, water stays where it belongs . . . no nearer than the weather brings it. The result is, more heavy-duty service *from* the engine, and less maintenance servicing *to* the engine, two factors *looked for* and *found* in Wisconsin Engines by oil producers and manufacturers everywhere.

4-cycle single-cylinder, 2-cylinder and V-type 4-cylinder models, 3 to 30 hp.

WISCONSIN MOTOR Corporation

MILWAUKEE 46, WISCONSIN

World's Largest Builders of Heavy-Duty Air-Cooled Engines

WRITE TO HARLEY SALES CO.

619 S. MAIN STREET, TULSA, OKLAHOMA
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OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS.

Trade Literature

Publications will be sent free.

(X) TANK EQUIPMENT

A new 32-page bulletin No. CP-2001 describing "VAREC" tank venting equipment is now available from the Vapor Recovery Systems Company. The bulletin illustrates and describes an extensive series of tank equipment, gas control, and safety devices for the safe handling and conservation of combustible or toxic liquids and gases in the petroleum, chemical, marine, food processing, paint and varnish and other industries.

Circle letter (X) on reply card.

(Y) MERCURY SWITCHES

A new condensed catalog on the Honeywell mercury switches is now available. The catalog covers five of designs of the Honeywell switches, with selection and application aids, and complete electrical ratings and data for the use of these switches in both a-c and d-c applications. A price list is included with terms of payment. Diagrams of the various applications clarify the details, simplyifying them for the reader. Minneapolis Honeywell Regulator Company.

Circle letter (Y) on reply card.

(Z) GAS ANALYSIS

A new edition of a reference manual describing the theory and practical application of gas analysis has been issued by the Fisher Scientific Company. It is the Fisher Gas-Analysis Manual, and this fourth revised edition, just from the press, has been completely rewritten to bring together all the up-to-date information on the subject, as well as the latest Fisher equipment for gas analysis. The 60-page manual discusses the theory of gas analysis and goes into considerable detail regarding the procedures involved in the various analyses. Complete instructions on maintaining and operating the equipment are given.

Circle letter (Z) on reply card.

(AA) VOLUME CONTROL PUMPS

An illustrated, 24-page, 2-color bulletin on controlled volume pumping and Milton Roy controlled volume pumps has recently been published by Milton Roy Company. Bulletin No. 151 will be of interest to industrial plants whose operations call for pumping a controlled volume of liquid in amounts as much as 50 gallons per minute or as little as 3 milliters per hour. The bulletin gives complete details on controlled volume pumping, and includes data required for selecting Milton Roy Pumps for specific applications.

Circle letter (AA) on reply card.

(AB) MEASURING INSTRUMENTS

Information on "how to select" electrical measuring instruments is provided in a 30-page instrument booklet available from the Westinghouse Electric Corporation. Seven basic selection factors are explained; types of instruments available in each major classification are listed on a full-page check chart; and, four typical selection problems are solved to help the reader make his selection. Complete lines of portable, switchboard, panel, recording, and socket instruments are described and illustrated, and functions of each are explained.

Circle letter (AB) on reply card.

(AC) RESISTANCE WELDING

A new technical booklet on the resistance welding of nickel and high nickel alloys has been issued by the Development and Research Division of The International Nickel Company, Inc. Designated as Technical Bulletin T-33, it contains 32 pages illustrated throughout by drawings and photographs. It also presents tables on mechanical properties, chemical compositions, recommended conditions for welding, and other information. International Nickel Company.

Circle letter (AC) on reply card.

(AD) POINT INDICATOR

A 4-page leaflet has been published on the Dia-Log free point indicator, which indicates torque as well as stretch to accurately determine the free point of stuck oil well pipe. It is in effect, an electronic strain gaze run in the well on an electric conductor cable and utilizing a surface indicating panel. The electronic indicating element of the tool measures the amount of either torque or stretch occurring in the 52-in. interval between the two sets of belly springs. The tool, it is claimed, will accurately indicate movements as small as one-thousandths of an inch. The Dia-Log Company.

Circle letter (AD) on reply card.

(AE) AIR POLLUTION

To show how the minute concentrations of SO_2 which are of interest in air pollution surveys can be continuously measured and automatically recorded, Leeds and Northrup Company has just published a revised 8-page folder—"Air Pollution by SO_2 Recorded by the Thomas Autometer." This new publication illustrates and describes the new application of the electronic Speedomax recorder to the autometer equipment, and presents non-integrating type of Thomas Autometer for continuous measurement in a range of 0 to 5 parts of SO_2 per million parts of air. Leeds and Northrup Company.

Circle letter (AE) on reply card.

(AF) PAYLOADER

The Frank G. Hough Company has just publishd a comprehensive, 12-page catalog, which will prove interesting and helpful to contractors, public works departments, utilities, mines, and pits. Entitled "Profitable Construction with Payloaders" this literature is filled with on-the-job photos showing a wide variety of earth-moving, material-handling, lifting, and carrying jobs being performed by the multi-purpose tractor-shovels known as Payloaders. Helpful job data, specifications, and features of the complete Payloader line are included, also illustrations of useful Payloader accessories such as backfiller blades, crane hooks, snow plows, and fork lifts.

Circle letter (AF) on reply card.

(AG) NICKEL ALLOY

A new technical booklet on the fabrication and design of nickel and high nickel alloy pipe and tubing has been issued. Designated as Technical Bulletin T-17, it contains 27 pages illustrated throughout by drawings and photographs. It also presents tables on mechanical and physical properties. ASME code requirements, recommended welding procedures, and other information. The International Nickel Company, Inc.

Circle letter (AG) on reply card.

(AH) PIPE WELLS

A 4-page bulletin describing a new means of rejoining crude oil, gasoline, and gas pipe lines was published recently. Weld+Ends Coupling, which, due to its special design and construction, accomplished effective sealing in a matter of minutes. Full pipe line pressure may be restored immediately, saving much costly shutdown time. The mechanical, high-pressure seal of the coupling eliminates any leakage into the bell-hole, and permits line flow to be restored immediately to purge all explosive mixtures. Also, if ground is soaked up with gasoline or crude oil, welding may be delayed for days or weeks until area is weld-safe. Pipe Line Development Company.

Circle letter (AH) on reply card.

(AI) SURFACE EXCHANGERS

The Henry Vogt Machine Company has announced a new bulletin covering its scraped surface exchangers. These surface exchangers differ from ordinary heat exchangers in that they use patented scraper elements to prevent fouling of the inner pipe surfaces. They serve as oil chillers, crystallizers and heaters in many processes in the petroleum refining and chemical industries. The scraper elements continuously sweep the inner pipe surfaces during operation and thereby maintain the highest possible rate of heat transfer between the product and the heat transfer surfaces. The bulletin is complete with diagrams, pictures, and data. Henry Vogt Machine Company.

Circle letter (AI) on reply card.

(AJ) VIBRATING SCREEN

A complete, 20-page illustrated booklet on Midel "UP" vibrating screens for the fast, accurate dry-screening of light and fine materials, and Model "NRM" liquid vibrating screens for the low-cost, high speed separation of solids from liquids, has been published. Both types of screens are available in a wide range of sizes. The "UP" can be supplied with single or multiple decks, and with semi-enclosed or totally enclosed steel housings where required. Descriptive material includes specific information on how to select the right screen and screen cloth for maximum operating efficiency; dimension tables, weights, and other data of value to the engineer and plant operator. The book shows a variety of actual installations, including sizing, reclaiming oilwell drilling mud, etc. Link-Belt Company.

Circle letter (AJ) on reply card.

(AK) ORGANIZED CURIOSITY

A new 12-page booklet entitled "Organized Curiosity, Inc.," tells the reader how to shorten a year to 500 hours, look through 5 in. of solid steel, photograph an invisible object, or make a dime appear 6600 ft in diameter. It is a picture story of International Harvester's 290-man research team checking the company's products for quality from design to delivery in the $4,500,000 manufacturing research department in Chicago, Illinois. International Harvester Company.

Circle letter (AK) on reply card.

(AL) INDUSTRIAL GLOVES

A new type of industrial glove has been developed by Plasticote Glove Company, Inc., and a bulletin describing these gloves is now available. The gloves are general purpose gloves with cotton fleece body and knit wrists, impregnated with Plasticote's soft pliable plastic. They are impervious to most chemicals, acids, and caustics, and protects the wearer against sparks or abrasion. They are available in colors. The "Black Major" glove is impervious to gasoline, kerosine, xylene, and hot oil. Plasticote Glove Company.

Circle letter (AL) on reply card.

(AM) GATE VALVES

A most comprehensive booklet on the Walworth Type 49 steel pipe line gate valves for crude, finished products, and gas lines may now be had by the public. The new type steel valves are claimed to give a tight shut-off when closed, yet offer a through-port, full-area, conduit-type passageway when the valve is open. The new valves have been designed on the through-port principle, with body and disc ports accurately indexed, and body ports bored to match connecting piping. The bulletin contains pictures, illustrations, and diagrams, and an article on radiography. By G. H. Blackburn, Walworth Company.

Circle letter (AM) on reply card.

(AN) CAUSTIC SODA

A new caustic soda bulletin prepared for all users of this important basic chemical is now available. Divided into four sections under tabbed headings, the booklet provides handy reference for particular problems on purchasing, handling and storage, equipment design, and technical data. Purchasing departments will find the comparison of various forms of caustic soda and the evaluation of shipping and ordering points helpful in selecting the form of this chemical most economical for use at their plants. The section on equipment design has been especially prepared to deal with the problems of engineering, construction and maintenance personnel. A separate leaflet covering instructions for safe handling of caustic soda tank cars is inserted in the flyleaf of the main bulletin. The Pennsylvania Salt Manufacturing Company.

Circle letter (AN) on reply card.

(AO) MANILA AND SISAL ROPE

A new data sheet describing its exclusive self-dispensing cartons of pre-measured manila and sisal rope is announced by the New Bedford Cordage Company. Besides photo and description of the new dealer-aid package, there is a table of the sizes, types and lengths available, with approximate gross weights of half and full-unit coils in each size. Data sheet No. 7903, is available from the manufacturer, his agents or distributors.

Circle letter (AO) on reply card.

(AP) NICKEL CAST IRON

A new 28-page bulletin compiled primarily for design engineers is now available to the public. The booklet presents many valuable characteristics of modern nickel cast irons and illustrates their acceptance throughout the industry. Twenty-seven useful tables, charts, and photomicrographs show how through the use of nickel, alone, or in combination with other alloying elements, the engineering properties of cast iron can be controlled to meet almost any reasonable combination of service requirements. International Nickel Company, Inc.

Circle letter (AP) on reply card.

(AQ) REVOLVER CRANES

A new catalog featuring American revolver cranes in industrial use has been released by American Hoist and Derrick Company. It is a pictorial catalog with views of the huge American revolver cranes working at ports and industrial plants throughout the world. It shows many specialized applications for this giant of industry. Contents include short job stories as well as rated lifting capacities of the five standard models.

This is a catalog that will be of interest to all persons concerned with large scale material handling problems. American Hoist and Derrick Company.

Circle letter (AQ) on reply card.

(AR) PIPING SYSTEMS

A new 34-page publication now available proposes an approach to the design of discharge header systems based upon the partial or complete elimination of back-pressure effects on tied-in safety-relief valves. Claimed to offer typical savings in the order of 75 per cent on the cost of conventional discharge piping, this manual gives operating test data on the company's complete line of FarriSeal and BalanSeal bellows-type Safety-Relief valves, as well as data of general interest to the engineer, draftsman, or designer of closed safety-relief discharge systems. A large part of the manual is devoted to theoretical and operating data in support of this thesis. The Ferris Company analyzes the economics of standard design practice as it affects the cost of pressure relief in cleared systems where control or recovery of the lading fluid is essential. The Farris Engineering Corporation.

Circle letter (AR) on reply card.

(AS) COMPRESSORS—BLOWERS

A new bulletin on centrifugal blowers and compressors has been published. The 52-page, 2-color bulletin contains comprehensive data on three types of De Laval centrifugal blowers and compressors: Multi-stage, single stage, end suction and single stage double suction. Capacities range from 1000 to 150,000 cfm for pressures to 150 psi and above. Special units are designed for higher pressures and for service at operating pressures to 1000 psig. The book is profusely illustrated with pictures and diagrams. De Laval Steam Turbine Company.

Circle letter (AS) on reply card.

(AT) CORROSION DATA

A new 12 in. by 9 in. card to hang on plant or office walls gives useful corrosion resistance information for several analyses of stainless steel tubing and pipe. Corrodents ranging in severity from fresh water and blood to sulfuric and hydrochloric acids are listed, with the recommended alloys for use with each. The reserve side of the chart contains data on standard tubing sizes, as well as dimensions, pressures, and tolerances for stainless pipe in schedules 5, 10, and 40. The Carpenter Steel Company.

Circle letter (AT) on reply card.

(AU) INDUCTION MOTORS

Data on ratings, construction, and types of large Allis-Chalmers vertical induction motors are contained in a new bulletin released by the company. Widely used for pumps and other vertical drives, vertical solid shaft induction motors described in this bulletin are available in ratings upwards from 60 hp at 200 rpm. Except for bearing arrangement, mechanical construction of the motors is basically the same as that of horizontal units.

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BOOKS

How Oil Is Found, *by W. A. ver Wiebe, University of Wichita, Wichita 14, Kansas. Pages, 243. Price, $8.50*

In this book on petroleum geology, the guiding theme is the delta-swamp environment, in which organic matter originates, and in which it is converted into liquid petroleum. The main part of the book is devoted to the more obscure principles underlying migration and accumulation of oil. One chapter discusses new methods of exploration based on subsurface stratigraphy. Descriptions of more than 50 actual producing fields are given, as well as data on oil production, per acre production, porosity measurements, permeability measurements, thickness of sands, and other data for the evalution of oil properties. Illustrations number 350, more than one-third of which are original with the author.

Proceedings of the National Conference on Industrial Hydraulics, *published by Armour Research Foundation of Illinois Institute of Technology, Technology Center, Chicago 16, Illinois. Pages, 347. Price, $3.50.*

Papers and discussions on both the fundamental and applied phases of industrial hydraulics are presented in this printing. Some of the papers cover: Cavitation vs. Diffuser Casings for Centrifugal Pumps, Fluidynamics of Bubble Trays, Flow Characteristics of Small Capacity Gas Rotameters, and the Application of Centrifugal Pumps. Industrial hydraulics is applied extensively by modern industry. This booklet is the fourth of a series devoted to publishing papers given at the Conference, which seeks to raise the general level of technical knowledge along that line.

Fuel Oil Manual, *by Paul F. Schmidt. Published by The Industrial Press. 148 Lafayette Street, New York 13, N. Y. Pages, 160. Price, $3.50.*

Those who buy, use, or sell fuel oil will be interested in Fuel Oil Manual. Data on: Properties of fuel oil, possibilities and limitations of each grade of oil, methods used to assure uniform quality and efficient combustion, how to diagnose fuel oil troubles, how to remedy them, and how to get maximum value from each fuel oil dollar, are covered. Under Remedies and Troubles are listed twenty-two of the common fuel oil troubles, their symptoms, and the remedy in each case. Chemistry of petroleum, petroleum refining processes, grades and types of fuel oil, gravity, heat of combustion, fuel oil treatments, and many other subjects are considered in the book.

Occurrence of Oil and Gas in Northeast Texas, *edited by Frank A. Herald. Published by The University of Texas, Bureau of Economic Geology, Austin, Texas. Pages, 463. Price, $10.*

The result of a cooperative project between East Texas Geological Society and Bureau of Economic Geology, this publication contains descriptions of 135 fields. Most of the field papers include structure maps and graphic type sections of rocks penetrated, with electric logs. Cross sections are shown of a number of fields. The papers present location, history, details of occurrence of oil and gas in the reservoir rocks, stratigraphic and lithologic details of the rocks, nature of trap, productive area, information on character of oil and gas recovered, and production history.

The Oil Record, *compiled by Henry Ozane. Published by Petroleum Industry Projects, 1420 New York Avenue, Washington 5, D. C. Price, $6. Pages, 353.*

Operating and financial data on American oil and natural gas companies for the year 1950 are presented in this book. The natural gas companies selected have been included principally because of their significance in the producing sector of the petroleum industry, and not because of their importance as utilities. Much of the information is presented in tabular form to facilitate reference and comparison. Statistics are generally carried over a three-year period.